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AERIAL SURVEYS OF ENDANGERED WHALES IN THE BEAUFORT, EASTERN CHUKCHI, AND NORTHERN BERING SEAS, 1982

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SUMMARY

This report summarizes the 1982 investigations of the distribution, abundance, migration, and habitats of endangered whales of the northern Bering, eastern **Chukchi**, and Beaufort Seas. Aerial transects and search surveys were flown in a specially modified Grumman Goose (**N780**) in the study region from mid-April through May and from mid-July through mid-October 1982. **Sonobuoys** were deployed to collect sounds, and photographs were taken to document distinctive markings on bowhead whales (**Balaena mysticetus**) for possible identification and in an attempt to estimate whale sizes. Overall, 366 sightings of 755 bowhead whales were made on 94 flights. During spring, 265 bowheads were seen. Two were observed passing east of St. Lawrence Island and 40 were seen north of the Bering Strait in late April. The migratory route near and east of Pt. Barrow was typical of 1979 to 1981 findings. **Belukha** whales were observed preceding and following the bowhead migration in spring. In early August, bowheads were observed moving westward in the eastern U.S. Beaufort Sea, mostly north of 70°20' N latitude. Throughout September whales were found progressively closer to shore in shallower water as the westerly migration progressed. In nearshore areas the migration peak occurred between 18 and 24 September. A second aircraft (**N642**) was used from 28 August until 15 October to monitor bowhead behavior near seismic operations and provide migration information for NMFS drilling restriction decisions. A rate of calf sightings per total sightings per survey hour was calculated from a combined (**N642** and **N780**) sighting count of 42 calves between 2 August and 17 October. Photographs of bowheads were calibrated in an attempt to obtain an index of length. Four bowhead carcasses were seen in the fall. All bowhead sounds recorded were aurally classified and tabulated.

Three hundred forty-eight gray whales (**Eschrichtius robustus**) were seen between St. Lawrence Island and Pt. Barrow from 23 May through 11 October. One hundred and eleven gray whales, including 18 calves, were seen nearshore off Cape Lisburne and between Wainwright and Peard Bay on 31 July. Overall, 45% of the gray whales seen were feeding. Additional sightings in 1982 included one minke whale (**Balaenoptera acutorostrata**), two narwhals (**Monodon**

monoceros) , twenty-three polar bears (Ursus maritimus), and many ringed seals (Pusa hispida), bearded seals (Erignathus barbutus), and walruses (Odobenus rosmarus) .

INTRODUCTION

BACKGROUND

The Naval Ocean Systems Center (NOSC) San Diego, California, has been funded by the Minerals Management Service (MMS), U.S. Department of Interior, since 1979 to conduct aerial surveys of endangered whales and, secondarily, other marine mammals in the northern Bering (above 62°N latitude), eastern Chukchi, and Alaskan Beaufort Seas. As part of its responsibilities under the Outer Continental Shelf Land Act, National Environmental Policy Act, Endangered Species Act, and other legislation, MMS has continued this work as an extension of previous studies (Ljungblad et al., 1980; Ljungblad, 1981; Ljungblad et al., 1982). It is expected that results of these studies will be useful to MMS in making sound decisions relative to leasing, exploration and development of the Outer Continental Shelf (OCS).

The bowhead (Balaena mysticetus) has been the principal species for which information has been collected during the past 4 years of the project. Historically, bowheads had a nearly circumpolar distribution north of the 60°N latitude. However, a long history of exploitation seriously reduced the number of whales in each of five geographically separate stocks (Breiwick et al., 1982). The western Arctic stock, now estimated to contain as many as 3,000 to 4,000 whales (Krogman et al., 1982; Dronenburg et al., 1982), is the group monitored in this study. From April to June these whales migrate northward from the Bering Sea through the eastern Chukchi Sea and across the Beaufort Sea to summer feeding grounds in the Amundsen Gulf area (Braham et al., 1980; Fraker and Bockstoce, 1980). From August through October the bowheads traditionally migrate westward into the Chukchi Sea and through the Bering Strait into the Bering Sea (Ljungblad et al., 1980; Johnson et al. 1981, Ljungblad, 1981). Much of their migration passes through or near areas under or proposed for energy resource development.

Gray whales (Eschrichtius robustus) have also been studied during this investigation. Principal areas monitored are the summer feeding grounds of the gray whale in the northern Bering and Chukchi Sea (Zimushko and Lenskaya,

1970; Braham et al. , 1979). This population is now estimated to number over 17,500 whales (Reilly, 1981).

This report summarizes the 1982 field results of regional surveys of endangered whale distribution and abundance in accordance with the objectives for the year as outlined below. A flight track/sighting chart and descriptive caption for each flight are presented in Appendix A. The distribution of 1982 survey effort and observed densities of bowhead and gray whales, with comparisons to 1979-1981, are presented in Appendix B.

OBJECTIVES

The objectives of our study have varied slightly each year. During 1982 they were to:

- 1) determine the seasonal distribution, migratory patterns, relative abundance, and habitats of endangered whales in the northern Bering, **Chukchi**, and Beaufort Seas.
- 2) obtain distributional information on non-endangered marine mammal sightings incidental to other investigations.
- 3) describe behavioral characteristics of endangered whales as observed in or near existing and proposed Federal lease sale areas of the northern Bering, eastern **Chukchi**, and Beaufort Seas.
- 4) derive estimates and indicators of relative and/or absolute abundance of endangered whales in or near the northern Bering, eastern **Chukchi**, and Beaufort Sea in existing or proposed Federal lease areas.
- 5) utilize such estimators/indicators to describe spatial and temporal patterns of endangered whale distribution, as appropriate.
- 6) synthesize and further analyze data obtained during investigations conducted in 1979-1982.

7) obtain or perform additional analyses of relative abundance indicators, sighting rates and habitat conditions of 1979-1982 fall data.

In conjunction **with** our survey objectives a second **aircraft (N642)** was dedicated for the period 28 August through 15 October **in** the Beaufort Sea to:

a) monitor seismic operations and provide migration information for seasonal drilling and seismic restriction decisions;

b) monitor whale behaviors to assess possible disturbance caused by seismographic exploration and related activities for the period 28 August through 2 October, 1982. The reader is directed to Reeves et al. (1983) for a complete report of results on the bowhead whale/geophysical vessel monitoring effort.

METHODS AND MATERIALS

STUDY AREAS AND AERIAL SURVEYS

The overall area surveyed included the Bering Sea north of 62°N latitude, the Chukchi Sea east of 169°W longitude, and the U.S. Beaufort Sea from Pt. Barrow to the U.S. Canadian Border offshore to 72°N latitude. This area was divided into survey blocks (Figure 1) suitable to line transect surveys (i.e., each block could be surveyed on one flight).

Transect blocks in the Beaufort Sea were roughly divided into three bathymetric zones: shallow (less than 50 m, blocks 1,3,4,5); transition (between 50 and 2000 m along the continental shelf break, blocks 2,6,7,11,12); and deep (greater than 2000 m, blocks 8,9,10).

Three types of aerial surveys were utilized to accomplish the objectives listed:

- 1) Line transect surveys with randomly determined starting and ending points were flown to determine distributions and estimate relative density. Coverage of no less than 10% of the total area of each block was planned.

- 2) Coastal surveys were flown to change field stations and to search for stranded marine mammals.

- 3) Search surveys in the spring were flown into areas of maximum probability of sighting bowhead whales and were designed to locate whales, observe their behavior and follow migrating individuals or groups. The exact routes of search surveys were dependent upon weather, sea state, ice conditions and previous patterns of whale sightings (i.e., number, headings, swim speed) . Systematic search lines were flown in spring. These lines were not randomly drawn, however, and should not be confused with line transect surveys. Systematic search lines were flown in areas of open water and in areas through which whales could migrate (ice coverage of 9/10 or less) which

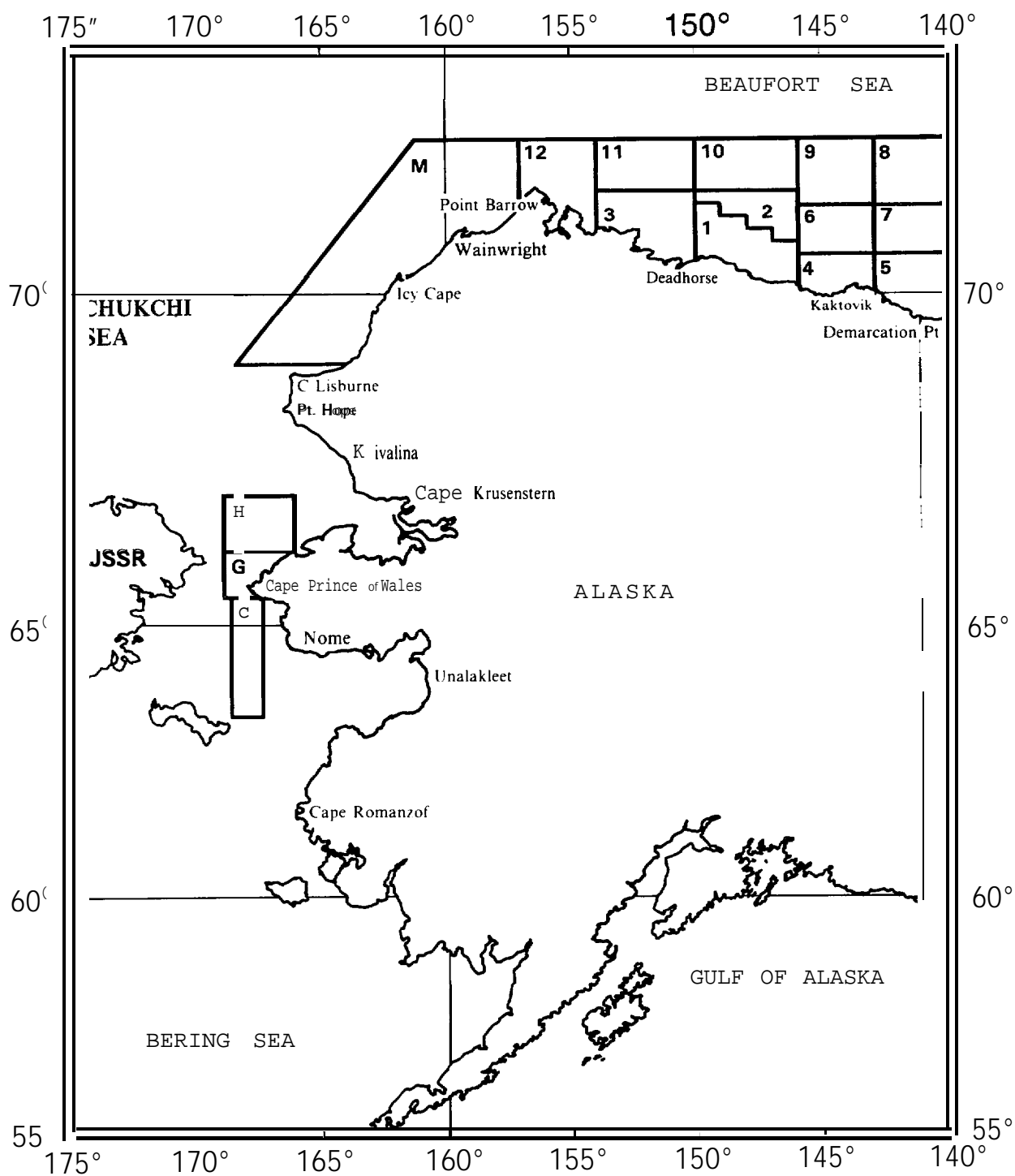


Figure 1. Survey blocks in the northern Bering, Chukchi and Beaufort Seas.

changed daily. Surveys were therefore designed "on the spot", in the aircraft, depending on where open water was found.

The year was divided into three field seasons: spring (April, May), summer (July), and fall (August, September, October). Respective bases of operation were Nome, Pt. Barrow, and **Oliktok** (spring); Nome and Kotzebue (summer); and Barter Island, Deadhorse, and Pt. Barrow (fall).

EQUIPMENT

Two aircraft (**N780**, **N642**) were used during this year's field effort. Each was a **Grumman** Turbo Goose provided by the Office of Aircraft Services, Department of Interior, Anchorage. Both were equipped with a Global Navigation System 500 (**GNS**), which has 0.37 km/h precision. The GNS provided continuous position updating and transect turning point programming. Surveys were planned to be flown at 305 m altitude, but weather forced the aircraft down as low as 40 m on some surveys while others were flown as high as 458 m to maximize visibility and to avoid disturbing the whales. The average survey altitude was about 150 m. Airspeed varied between 222 and 296 km/h. The plane used primarily for behavioral studies in the fall (**N642**) had a maximum flying time of 5.5 h, while the principal aircraft (**N780**) used for line transect surveys throughout the season had a maximum range of 7.5 h.

AN/SSQ-41A, **AN/SSQ-41B** and **AN/SSQ-57A** sonobuoys, are passive acoustic listening systems that contain hydrophore arrays and transmitters. They were used successfully for recording marine mammal and geophysical boat sounds. These units have frequency responses of 10 Hz to 5 kHz, 10 Hz to 15 kHz, and 10 Hz to 20 kHz, respectively. **Sonobuoys** are designed to be dropped from the aircraft by means of a rotochute or parachute. Once in contact with water, a saltwater-activated battery energizes the unit. At that time the parachute assembly is jettisoned and the hydrophore array drops to a preselected depth of 18.2 or 91.4 m (60 or 300 ft). The sounds picked up by the hydrophores are then amplified and transmitted to a broadband receiver aboard the aircraft. The receiver output was connected to a Nagra IV SJ recorder with a frequency response of 25 Hz to 10 kHz \pm 2 dB at a recording speed of 9.5 cm/s. This

recorder has two channels permitting simultaneous recording of waterborne sounds and verbal comments.

Equipment used for the first time in our aerial surveys included an onboard computer and a video system. Both afforded additional data acquisition capability and increased precision this year. The Hewlett-Packard 85 (HP-85) computing system was used to store and **later analyze** the **flight** data. The computer was interfaced with the GNS 500 for precise, automatic input of entry number, time, latitude and longitude. An RCA video camera recorder was used to record bowhead whale behavior sequences. Audio from live headset microphones and from **sonobuoys** was recorded simultaneously by both the video recorder and the Nagra tape recorder. It has been used to analyze behavior patterns.

DATA COLLECTION (N780)*

There were four seats in the cockpit, which has large side windows affording good visibility to all observers. Observers were positioned so that the **person** navigating was in the co-pilot's seat, the recorder with the computer was in the left-rear seat, and an observer was **in** the right-rear seat. The pilots and all observers were connected to a common communication system. The pilot acted as a limited observer. Each observer was provided with an inclinometer.

Whenever possible the following information was recorded by means of a 28-key data format on the computer: position coordinates; altitude; species identification; number in the group; true heading; and estimated swimming speed. An inclinometer angle, taken when the sighting was abeam of the aircraft, was used to determine sighting distances, which were needed for the derivation of an index of abundance. Notations were also made regarding the whales' behavior, responses to the aircraft, and the location of **sonobuoy** drops. Sea state and ice coverage were recorded according to the Beaufort scale outlined in Chapman (1971) and the aerial ice reconnaissance and ice

*See Reeves et al. (1983) for N642 data collection methods.

terminology presented in the Naval Hydrographic Observers Manuals (**H.O. Pub. No. 609, H.O.Misc. 15603**), respectively.

Any one of four different data entry formats could be selected on the computer, depending on the reason for entry. Whenever possible, the full 28-key data entry format was used when cetaceans were sighted (Table I). If there were many whale sightings within a short period of time, an abbreviated 17 key entry format could be used. A position update 14-key format, including data on weather, visibility, ice coverage and sea state, was entered in the absence of sighting data no less than every 10 minutes. **An** even shorter 7-key entry format was used for extremely rapid data updates occasioned by multiple sightings occurring in a very short period of time.

The computer provided several advantages over manual recording of data. **It** reduced errors in recording and in transcription of data to other forms and users. It provided faster and more accurate data updates because of the automatic input of entry number, time, latitude, longitude, and altitude. Analyses were simplified because the data were readily available and analyzable without reformatting or transcription to other systems.

Attempts were made to photograph or video tape each bowhead whale sighted during aerial surveys. Still photographs were made with hand-held 35 mm cameras (Olympus **OM-1**) with 210 mm lenses using ASA 200 film. Typical exposures were made at one five hundredth or one thousandth of a second shutter speed at appropriate F-stops. The altitude of the aircraft and the photograph roll and frame number were noted and stored in the computer. The approach angle of the aircraft to sighted whales was kept as close to 22° as possible so that the angle from the aircraft to the whales was similar in most sightings.

Brightly painted buoyant sticks, 1.0 m long, were ejected from the aircraft and photographed at a **22° angle** at various altitudes; 152 m (500 ft), 305 m (1000 ft), 610 m (2000 ft) and 915 m (3000 ft). These images of the meter stick were measured and used in an attempt to calibrate the measurement of whales from photographs.

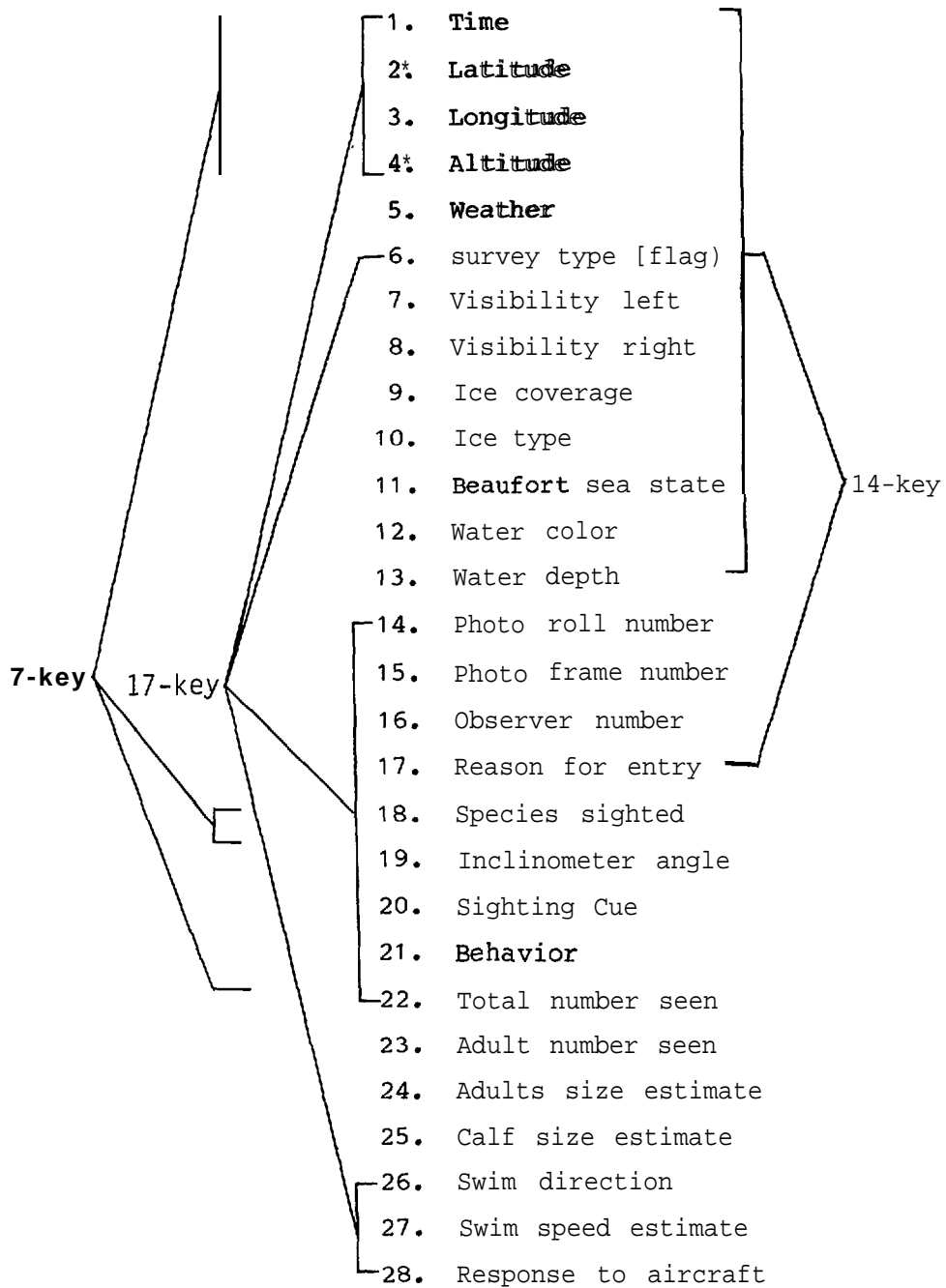


Table I. Data entry sequence on the Hewlett-Packard 85 computer. The full 28-key, abbreviated 17-key, 14-key and 7-key entry formats are delineated by flow chart lines.

The ability to sight surfaced animals ("**sightability**") was reduced due to such natural factors as rain or snow squalls, fog, haze, glare, high sea states and the percentage of ice coverage. Changing aircraft altitude because of weather conditions and cloudy water near river mouths and shorelines also reduced sightability. A quantitative assessment of sightability effects on data acquisition is underway.

Operational Definitions Of Observed Bowhead Whale (**Balaena mysticetus**) Behaviors

Bowhead behaviors were classified by means of the operational definitions outlined in Table II. Behaviors were grossly cataloged into two types for purposes of discussion: migratory behaviors, which included swimming and diving; and social behaviors (typically observed in groups) such as milling, feeding, mating, calf nurturing, lying still, and displaying. Displays included breaches, spy hops, tail lobes, and flipper **slaps**.

Data Analysis

Whale sighting locations were plotted seasonally to determine overall distribution. Bowhead relative abundance and migratory timing were analysed as number of sightings per survey hour. To determine if the headings of whales were directional (**nonrandom, unimodal**) Rayleigh's test, the Laubscher-Rudolph test, and a chi square comparison of **octants** were used (Batschelet, 1972). Differences in whale sizes between groups were tested using the Student's t test. Disparity in proportions of behaviors observed and responses to aircraft were also tested using the chi square test (Zar, 1974).

Attempts were made to estimate bowhead whales' lengths, not as an absolute quantity (e.g., Davis et al., 1983), but as a relative indicator, or index. The largest whale measured was assigned a value of 1.0 and all others were compared to that length. These indices, though not a histogram of absolute lengths, may be used to comment on general topics such as temporal or spatial population segregation and relative growth rates.

MIGRATORY	Behavior	Description
	Swimming	Forward movement through the water propelled by tail pushes; performed individually or as part of a group.
	Diving	Change of swimming direction relative to the water surface; may or may not be accompanied by lifting of the tail out of the water; performed individually or as part of a group.
SOCIAL	Milling	Group of whales swimming slowly around one another in close proximity (<100m) at the water surface.
	Feeding	Group of whales diving repetitively in cloudy water often accompanied by mud streaming from the mouth and defecation upon surfacing; nearly synchronous diving and surfacing has been noted as has echelon formation surface feeding with swaths of clearer water noted behind the whales.
	Mating	Ventral-ventral orientation of a pair of whales often with at least one other whale present to stabilize the mating couple; usually in a group of milling whales; pairs appear to hold each other with their pectoral flippers and may entwine their tails.
	Nurturing	Calf nursing; proximal swimming to an adult; adults coalescing around a cow-calf pair.
	Lying Still	Single OR group of whale(s) at the surface with head, or head and back exposed, showing no movement; more commonly observed in heavy ice conditions than in open water.
DISPLAYING	Flipper-Slapping	whale on its side striking the water surface with its pectoral flipper one or many times; seen only in groups, often when slapping whale is touching another whale.
	Tail Lobbing	whale hanging vertically in the water head down with tail out of water and waving back and forth striking the water surface; seen only in groups, two whales were seen tail lobbing near each other for over 10 minutes.
	Spy Hopping	Whale rising vertically from the water such that the head and up to one third of the body including the eye is exposed; seen only in groups.
	Breaching	Whale exiting vertically from the water such that half to nearly all of the body is exposed then falling back into the water, usually on its side, creating a large splash and presumably some sounds.

Table II. Operational definitions of observed bowhead whale behaviors.

Measurements were made on "good" slide images of the l-m calibration sticks and whales that were projected on a screen. "Good" images included those in which the whale was parallel to the water surface and to the track of aircraft and not in a flexed or contorted posture. Whale length from tip of jaw to notch of the flukes was measured. Images were measured to 0.5-mm precision, which represented between 0.6% and 2.7% of a whale's length. Water refraction, camera vibration and theoretical elongation of the image due to aircraft speed could additively account for several percent more variance but are considered inconsequential when determining a length index rather than absolute length. If more than one image was available of a single whale because of multiple passes or multiple frames on the same pass, the size values were averaged. Measurements of one set of slides produced by three different observers were averaged to reduce the effect of individual variations in measurement techniques.

RESULTS AND DISCUSSION

Overall flight effort for the 1982 field season is presented in Table III and Figure 2. A total of 377 hours were flown, with approximately 70% of the flight effort in the Beaufort Sea, 13% in the **Chukchi** Sea and 17% in the northern Bering Sea.

SPRING (APRIL, **MAY**)

Survey Effort and Rationale

In the spring, flight effort was designed to find and follow bowhead whales migrating northward through the northern Bering and **Chukchi** Sea and eastward across the Beaufort Sea. To this end, search surveys along open water lead systems were the predominant survey types flown (Flights 1 to 13).^{*} Once bowheads were observed passing Pt. Barrow, systematic search lines were flown in the Beaufort Sea (Flights 14 to 17) to evaluate bowhead distribution on their easterly migration.

The spring season was 38 days long (17 April to 25 May). Surveys were flown on 23 days (60.5%). There were 15 down days: 4 (10.5%) for aircraft maintenance, 10 (26.3%) for **poor** weather, and 1 (2.6%) for logistic coordination.

Survey Conditions Summary

The ice conditions in the Bering, **Chukchi** and Beaufort Seas this year were quite variable, compared with 1981. The ice "broke up" and refroze twice in the winter before the survey season began in April (**Dronenberg**, et al., 1982). During the spring survey season (17 April-25 May), heavy ice coverage predominated. Coverage was highly influenced by wind, currents and to some degree by river runoff near the river mouths.

^{*}See Appendix A for all flight track/sighting charts.

BH = bowhead whale WS = walrus
 BE = belukha whale BS = bearded seal
 GW = gray whale RS = ringed seal
 MW = minke whale PN = unidentified
 NW = narwhal pinniped
 PR = polar bear CT = unidentified
 cetacean

Flight No.	Date	Flight effort	Sightings: Total/calf = dead (not included in total count)										
			BH	BE	GW	MW	Nw	CT	WS	BS	RS	PN	PR
1	Apr 23	Search Survey, Bering Strait	0	9					89	3	1		—
2	24	Search Survey, St. Lawrence Is.	2	3					6	0	0		
3	25	Search Survey, St. Lawrence Is.	0	16					192	10	2		
4	26	Search Survey, s. Chukchi Sea	28	56			2		177	2			
5	27	Search Survey, S. Chukchi Sea	1	93					0	1	0		
6	29	Search Survey, St. Lawrence Is.	13	86					67	5	0		
7	May 1	Coastal Survey, Nome to Pt. Barrow	3	61					2	24	11		
8	2	Search, Pt. Barrow to Deadhorse	0	0					0	0	0		1
9	3	Search, Pt. Barrow to Deadhorse	36	33					0	22	0		
10	4	Behavioral observation Pt. Barrow	33	4					0	0	0		
11	5	Search Survey, pt. Barrow to Deadhorse	11	07					0	0	0		
12	7	Coastal survey, Pt. Barrow to Nome	13	45					0	1	1		
13	9	Coastal survey, Cape Lisburne to Pt. Barrow	5	1					0	1	0		
14	10	Systematic search, Pt. Barrow to Deadhorse	12	06					0	0	0		
15	12	Systematic search, Pt. Barrow to Deadhorse	36	69					0	3	0		

Table III. Overall flight effort and sightings, by date.

Flight No.	Date	Flight effort	Sightings										
			BH	BE	GW	MW	NW	WT	WS	BS	RS	PN	PR
16	13	Systematic search, Pt. Barrow to Deadhorse	60/1C	114					2	13	2		
17	14	Systematic search, Pt. Barrow to Deadhorse	9	53					0	18	0		
18	19	Transit Pt. Barrow to Oliktok	0	0					0	7	0		
19	21	Systematic search, Oliktok to Barter Is.	0	0					0	29	2		1
20	22	Coastal search, wainwright to Nome	3/1C	4					1	17	10		
21	23	Transect survey, Block C	0	8	2				210	3	4		
22	24	Transect survey, Block A & St. Lawrence	0	12					62	7	0		
23	25	Search King Is.	0	71					2092	7	8		
24	July 10	Transect survey, LGL, N. Bering Sea			17							1	
25	11	Transect survey, LGL, N. Bering Sea			39(1D	1				2		10	
26	12	Transect survey, LGL, N. Bering Sea			28(1D				(1D)			3	
27	17	Transect survey, LGL, N. Bering Sea			17							9	
28	18	Transect survey, Blocks G & H			9/1C				(7D)			6	
29	19	Transect survey, Block C		(1D)	54(2D				171D)			4	
30	24	Transect survey, Block C		3	42							1	
31	30	Transect survey, Blocks G & H			3			1	(39D)			1	
32	31	Coastal survey Kotzebue to Barter Is.			11/18C (2D)				00(62D			49	
33	Aug 1	Search, Barter Is. to Deadhorse	0										
34	2	Transect survey, Block 5	7										
35	5	Transect survey, Block 4	0										
36	6	Transect survey, Blocks 4, 5 & 7	32	7								4	1

Table III. Overall flight effort and sightings by date. (Cent'd)

Flight No.	Date	Flight effort	Sightings										
			BH	E	GW	MW	NW	CT	WS	BS	RS	PN	PR
37	7	Transect survey, Blocks 6, 7 & 8	27/2C	1							1	1	2
38	8	Transect survey, Blocks 6 & 7	19	5								2	
39	11	Transect survey, Block 4	0								2		
40	12	Transect survey, Blocks 1, 2 and 6	0	5								2	
41	14	Transect survey, Block 4	0									5	
42	14	Transect survey, Block 6	3	5									
43	15	Transect survey, Block 7	20/3C	3							1	2	3
44	16	Transect survey, Blocks 5, 6 & 7	14/1C	8						3	1	17	1
45	17	Transect survey, Blocks 6 & 2	3	5						1	1	8	
46	18	Transect survey, Blocks 5 & 7	14/4C	8						1		11	
47	20	Transect survey, Block 7	2/1C	5								2	
48	20	Transect survey, Block 4	0							1		6	
49	21	Transect survey, Block 6	1									2	
50	22	Search, Block 1	0									1	
51	23	Transect survey, Blocks 6 & 4	0	1								1	
52	24	Transect survey, Blocks 1 & 2	0									4	
53	24	Transect survey, Block 9	2	8									
54	25	Transect survey, Block 5	1									5	
55	28	Transect survey, Block 4, 5 & 7	0								1	21	
56	Sept 1	Transect survey, Block 5	0									2	
57	1	Transect survey, Blocks 1 & 4	0							1		14	
58	2	Search, block 5	1							1		4	
59	4	Transect survey, Block 5	5							3		4	
60	7	Transect survey, Blocks 4 & 6	0							1		3	
61	8	Transect survey, Blocks 8 & 9	4/1C								1		1
62	11	Transect survey, Blocks 5 & 7	0										
63	14	Transect survey, Blocks 4 & 5	1									2	
64	15	Transect survey, Block 5 .	42/3C								1	1	
65	15	Transect survey, Blocks 4 & 6	1									2	
66	16	Transect survey, Block 5	61/4C									2	
67	18	Transect survey, Blocks 1 & 3	0									11	1

Table III. Overall flight effort and sightings, by date. (Cent'd)

Flight No.	Date	Flight effort	Sightings										
			BH	B]	GW	MW	NW	C:	WS	BS	RS	PN	PR
68	21	Transect survey, Block 3	2									2	
69	23	Transect survey, Block 3 & 11	(1D)						1			97	
70	24	Transect survey, Blocks 1 & 2	159/3c									8	1
71	25	Transect survey, Blocks 3 & 12	0									7	
72	27	Transect survey, Blocks 3 & 11	2										
73	28	Transect survey, Blocks 12 & M	14(1D)		18					1		2	
74	29	Transect survey, Block 1	5										
75	30	Transect survey, Blocks 3 & 6	4										
76	Ott	2 Transect survey, Blocks 12 & M	7	1	2			1	25	8			
77		3 Transect survey, Block M	2(1D)		4				2				
78		4 Transect survey, Blocks 1 & 3	10/1C										
79		5 Transect survey, Block 11	7	E							10		
80		7 Ice recon.	0										
81		9 Transect survey, Blocks 12 & M	9						362		14		2
82		10 Transect survey, Block 3	0							1			
83		11 Transect survey, Block M	0		2				68		32		
84		12 Transect survey, Blocks 12 & M	3								7		3
85		15 Search survey, Deadhorse to Herschel Is.	1										2
86	16	Transect survey, Block 11	0	1									
87	17	Transect survey, Blocks 12 & M	1	25									
88*	6	Transect survey, Blocks 4 & 5	3										
89*	9	Ice recon., Block 6	0										
90*	11	Transect survey, Block 1	0									5	1
91*	12	Transect survey, Block 4	0										
92*	13	Transect survey, Block 5	0										
93*	14	Search survey, Herschel Is.	1										
94*	15	Search survey, Block 10	0									1	3
Total			755	1:	148	1	2	2	1458	197	13	45	23

(* N642 flights)

Table III. Overall flight effort and sightings, by date. (Cont'd)

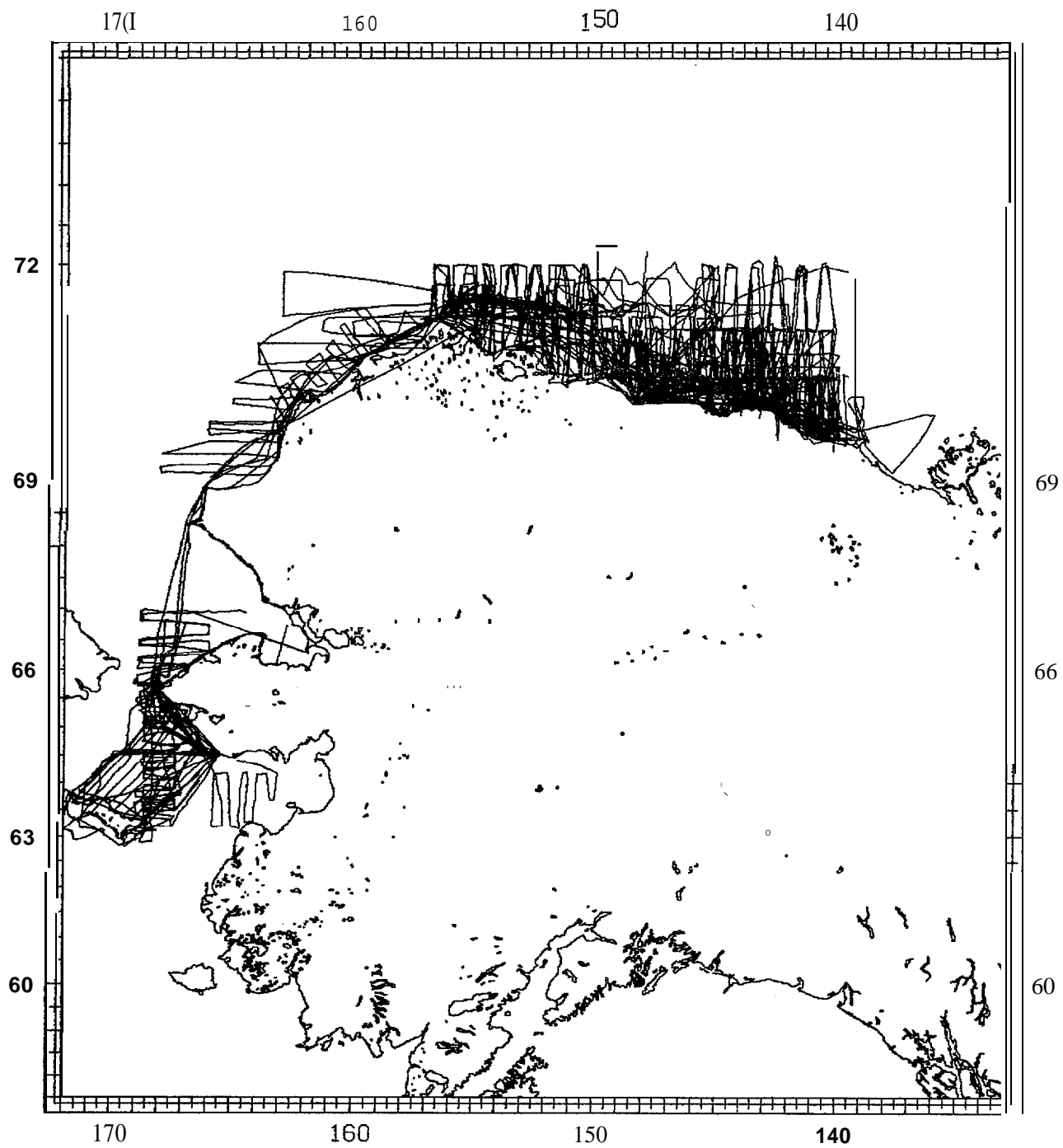


Figure 2. Overall flight effort, 1982.

Satellite photography (Figure 3) shows the general ice conditions in late April. In the northern Bering Sea winds and currents formed large areas of open water in the lee of land formations such as St. Lawrence Island. Most other areas were covered by 8/10 to 9/10 broken floe ice.

In the Chukchi Sea very heavy ice (greater than 9/10 coverage) predominated. It consisted of broken floe with very large (over 2 km) pieces of pan ice. Winds and wind-driven currents opened up a nearshore lead system, extending from the Icy Cape and Cape Lisburne area to Pt. Barrow.

In the Beaufort Sea shore-fast ice extended over all shallow (less than 20 m) water areas. There was no open water south of the 71° N latitude line from Pt. Barrow east to the 147° W longitude line. Broken or cracked ice covered 8/10 to 9/10 of the area between the 71°N and the 72°N latitude lines. Small "ponds" of open water existed in the cracks or between large pieces of pan ice but these were usually quickly covered by new or grease ice. There were no well defined east-west leads as noted in 1981 . (Ljungblad et al., 1982.) The area north of the 72° N latitude was generally solidly covered as in previous years, although very little pack (multi-year) ice was noted. In late May, the ice coverage in the Beaufort Sea changed slightly due to terrestrial runoff and melting. Less than 9/10 coverage was noted east of Harrison Bay as well as a lead system that extended from 70°27'N, 146°W east to just north of Barter Island at 70°10'N, 142°W.

Sea states during spring surveys ranged from a Beaufort 01 (light ripple, wind 1-6 knots) to 07 (foam, wind 28-33 knots), but averaged 03 (scattered whitecaps, wind 11-14 knots) . The exception was 1 May (Flight 7) in the northern Chukchi Sea when sea states averaged Beaufort 05 (many whitecaps, wind 19-24 knots) to 07.

Distribution

Bowhead whales were seen from St. Lawrence Island to pt. Barrow and in the Beaufort Sea as far east as 144°W longitude at 71°30'N latitude. In the Beaufort Sea, bowheads quite commonly left holes ("ice tracks") in freshly

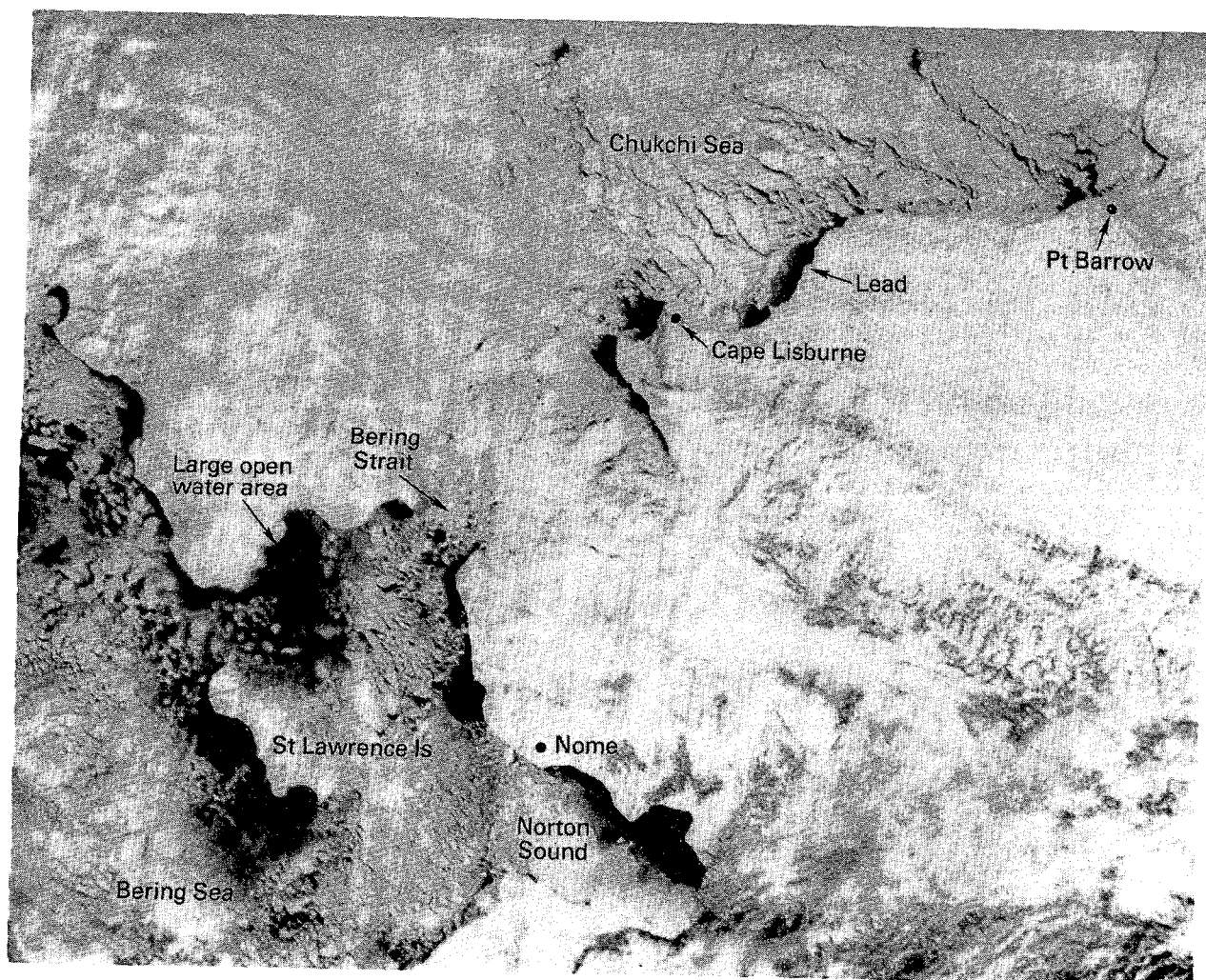


Figure 3. Satellite photograph, 26 April 1982. Note open-water areas northwest of St. Lawrence Island and along the northwest coast in the Chukchi Sea.

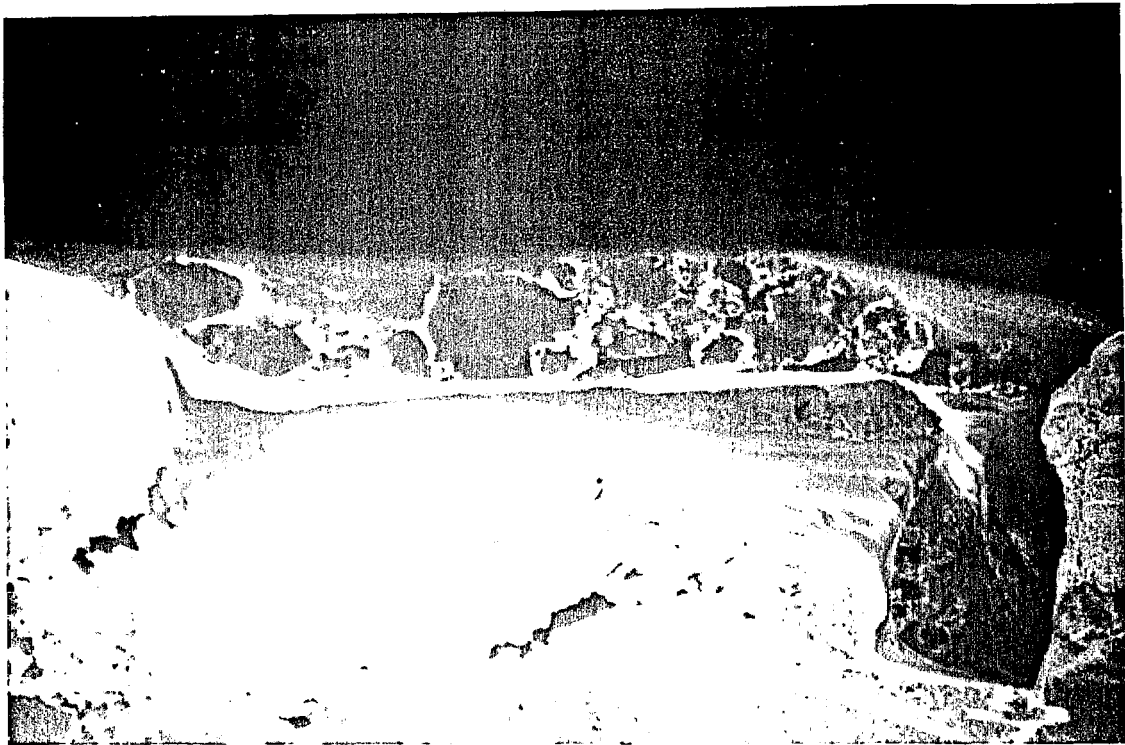


Figure 4. Bowhead ice track photo, May 1982.

formed ice when they surfaced to breathe (Figure 4). Ice tracks were oval-shaped holes estimated to be about 3 m along their longest axis. Small pieces of broken ice were commonly seen scattered around the perimeter of each hole, indicating that the break came from beneath the surface. The tracks were clearly visible when formed but deteriorated within several hours and were seen along the migration route intermingled with actual whale sightings.

The overall distribution of 144 sightings, representing 265 bowheads seen between 24 April and 25 May, is shown in Figure 5. In the northern Bering Sea, two bowheads were seen northwest of St. Lawrence Island and two whales were sighted east of the island on 24 April and 29 April, respectively. All other bowheads seen in early spring (25 to 29 April) were found in or near the Bering Strait, or in the nearshore lead in the Chukchi Sea between Cape Lisburne and Pt. Barrow.

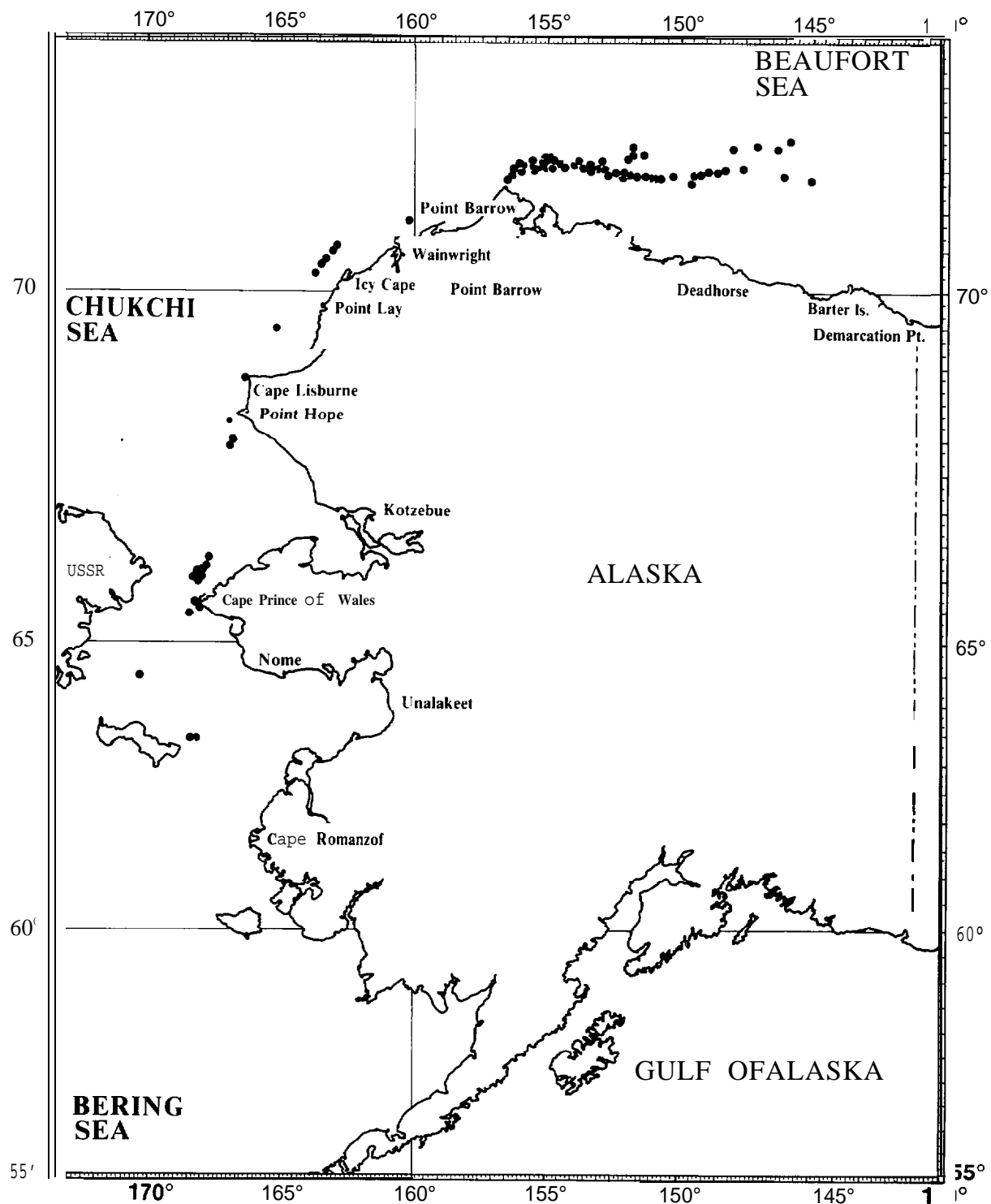


Figure 5. Overall distribution of 144 sightings representing 265 bowhead whales seen between 24 April and 25 May 1982.

In the Beaufort Sea bowheads were observed from Pt. Barrow east to 180 km northwest of Barter Island between 1 May and 25 May. Sightings were clustered around the **71°30'N** latitude line where ice coverage remained 8/10 to 9/10 throughout the survey period. Transect surveys were not flown in the spring; thus, line transect density or abundance estimates were not calculated.

Migration Timing and Habitat Relationships

Bowheads observed in late April were distributed over a 1000 km range from St. Lawrence Island **past** Pt. Barrow and were seen at either of these two extremes on two consecutive flights on 29 April and 1 May.

Two bowhead whales were sighted north and east of St. Lawrence Island at **64°23.5'N, 170°17.8'W** on 24 April (Flight 2) and two were seen swimming east of the island (at approximately **63°30'N, 168°30'W**) on 29 April (Flight 6). Though bowheads typically **migrate** to the west of the island, some may migrate around the east end using what is considered a less important route, (Braham et al., 1980). Bowheads seen in the **Chukchi** Sea were located just north of the Bering Strait or in the nearshore lead between Cape Lisburne and Pt. Barrow.

Fewer bowheads were observed in the Bering and **Chukchi** Seas in 1982 compared with previous years. There were no large groups or concentrations of whales north of the Bering Strait or north of St. Lawrence Island as there were in 1980 and 1981. This may be attributed to the fact that there was very little open water in the northern Bering Sea or southern **Chukchi** Sea in 1982, or it may be that the presence of such concentrations is highly variable. It is possible that some **bowheads** may have proceeded northward from the northwestern Bering Sea along the Soviet coast, where, as the satellite imagery showed, there was little ice coverage to inhibit their migration (see Figure 3). Usually bowheads move northeastward across outer Kotzebue Sound through small cracks and leads that develop along the edge of the landfast ice between the Bering Strait and Pt. Hope (**Braham** et al., 1980). We did not encounter any leads along the landfast ice in 1982 and suspect that whales may have

passed through the **Chukchi Sea** further west than we noted previously (west of 169°W longitude), utilizing open-water cracks and discontinuous leads to make their way to the nearshore lead at Pt. Hope.

Five bowheads were sighted at Pt. Barrow as early as March (Dronenberg et al., 1982) during one of the ice breakups. The main migration past the north slope, which seemed to be dependent upon the ice conditions, began in mid-April and lasted through mid-May (Dronenburg et al., 1982). After bowheads rounded Pt. Barrow, they were observed heading due east on a mean heading of 87.3° (true) with significant clustering about this mean (Rayleigh test, $v=10.61$, $p < .001$, $n= 66$) migrating through the little open water that existed. Ice tracks were observed often interspersed with whale sightings. As the whales moved east they began dispersing over a broader area. The overall distribution of bowheads in the Beaufort **Sea** clustered around the 71°30'N line and largely echoed the findings of previous years.

The portion of the migration past Pt. Barrow that we observed was divided into two phases or "pulses" (Braham et al., 1980). The first phase occurred between late April and 6 May, and the second from 9 May to 25 May. Analysis of sightings per unit effort (SPUE) of searching (1.0 hour of flight time) shows two periods of peak sightings, one in each phase or pulse, on 3 and 4 May and on 12 and 13 May (Figure 6). These times agree closely with sighting peaks from the census ice ~~camp~~ counts (Dronenburg, et al., 1982). This may be a coincidence due to good sighting conditions.

The whales in the first phase were estimated to have been of medium index size ($\bar{x} = 0.524 \pm 0.119$, s.d.) and travelled in groups of 2 to 5 animals. Social behaviors were common including possible mating activity. Some whales were observed covered with mud, indicating feeding or exploration of the bottom or near-bottom. No calves were seen in the first phase. Only 12% of the animals encountered responded to the aircraft. Ice coverage during this phase was 8/10 to 9/10. After 9 May (the second pulse), whales of a larger size ($\bar{x} = 0.721 \pm 0.163$ s.d.) were observed. On the basis of Student's t test, these animals were significantly ($p < 0.01$, $t = 3.46$, $df = 41$) larger than those seen during the first phase. Whales in the later pulse travelled

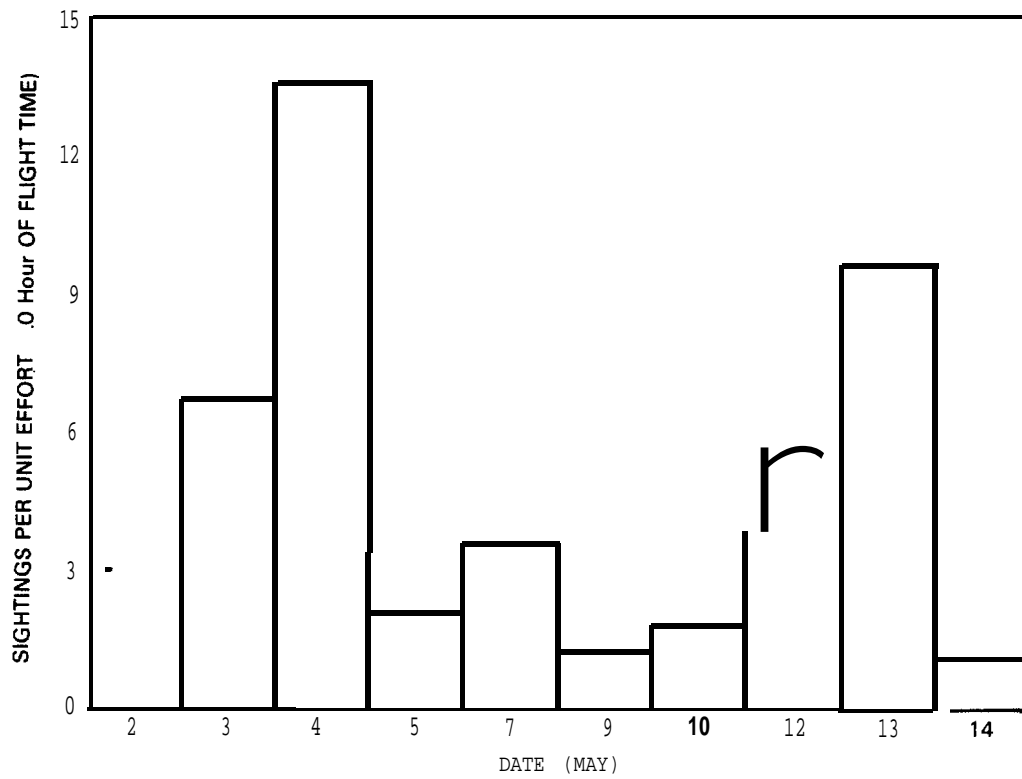


Figure 6. Bowhead sightings per unit effort (SPUE), spring 1982.

east with fewer social displays. Ice coverage averaged 7/10 to 8/10 and consisted of broken floe ice with more scattered open-water "ponds."

Two cow-calf pairs and several suspected cow-yearling pairs were seen in the second phase. On 13 May an estimated 6-m calf and an estimated 14-m cow were observed off Pt. Barrow at **71°34'N, 155°17'W** as they were heading east at about 3 km/h. On 22 May a cow-calf pair was observed in the Chukchi Sea at **67°59'N, 166°48'W**, far south of the earlier portion of the migration. The estimated 15-m cow was brownish with a white chin patch and was slowly moving north. The estimated 6-m calf, which was mottled tan with a light rostrum and white on the fluke stock, was seen alone, under, over or beside the cow. No recruitment rate was derived based on these sightings. A further discussion of bowhead calf sightings is presented in the "fall" section of this report. After 20 May, 26 calves were reported from the ice census camp, (Dronenburg et al., 1982).

Behavior and Sound Production

The most common behavior observed in the spring was active migration (Table IV). Most whales were solitary or in loose moving groups. In the northern **Chukchi** and Beaufort Seas, the migration did not appear as hurried or as determined as in the south or as reported in previous years. Social behavior, including possible mating, was mixed with active swimming. In fact, some whales on the **Chukchi** Sea were observed swimming south, or against the migration. Compared with 1981, more social behaviors (22.7%), possibly including mating, were noted in the **Beaufort** Sea. In past years the migration was observed to be direct and uninterrupted through the Beaufort Sea.

Three bowheads covered with mud were observed east of Pt. Barrow diving in less than 20 m of water. It is not known if this activity was associated with feeding. Many groups of up to five bowheads were observed milling and touching northeast of pt. Barrow. Twice a whale was observed to approach and apparently alter the heading of another whale. The two then resumed the heading of the approached whale. The resulting track resembled an "S." Several hours of video and audio tape recordings of these whales were obtained.

	Bering sea #/%	Chukchi Sea #/%	Beaufort Sea #/%	Tota l #/%
Behavior				
Swim	3/60.0	23/38.3	139/69.5	165/62.3
Dive	0/0 .0	13/21 .7	11/5.5	24/9.0
Still	0/0.0	18/30.0	1 6/8	34/12.8
Mi ll	0/0 .0	2/3.3	21/10.5	23/8.7
Display	0/0.0	0/0.0	3/1 .5	3/1 .1
Feed	0/0.0	0/0.0	1/0.5	1/0.4
Mate	0/0.0	3/5.0	9/4.5	12/4.5
None	2/40.0	1/1.7	0/0.0	3/1.1
Total	5/100	60/?00	200/100	265/100
Mean Group Size	1.20	1.58	2.00	1.84
Response to Aircraft				
Yes	0/0.0	6/33.3	9/9.2	15/12.7
No	2/100.0	12/66.7	89/90.8	103/87.3

Table **IV.** Summary of bowhead behavior, group size and responses to aircraft, spring 1982.

Few bowheads in the Chukchi (33.3%) and fewer in the Beaufort (9.2%) responded to the aircraft. (Table IV).

Sonobuoys were dropped once in the **Chukchi** Sea, three times in the northern Bering Sea, and seven times in the Beaufort Sea. Location and recorded subject of **sonobuoy** drops are summarized in Table V. **Sonobuoys** were dropped near bowhead whales (and occasionally in areas where whales might be) in an attempt to determine their presence acoustically. Sometimes more than one **sonobuoy** was dropped in an area when additional whales were sighted or if the first one malfunctioned. Hydrophore depth was usually 18.2 m.

A comprehensive aural analysis of bowhead sounds recorded in spring 1982 is provided in Table VI. All sounds were played back at the recorded speed and placed into simple or complex moan, and trumpet sound categories based on past analyses of bowhead sounds (Ljungblad et al., 1982). Call rate was derived as a relative index of sound production by dividing the number of calls by the number of whales seen for a sample unit of duration. Simple moans are tonal, usually frequency modulated (FM) sounds often with harmonic structure. Simple moans were classified as follows:

- up - ascending frequency modulation
- down - descending frequency modulation
- constant - no discernible frequency modulation
- inflect - combined ascending and descending frequency modulation
- high - short (FM) calls above 800 Hz.

Complex moans are sounds with a **pulsive** character, and varied component structure. Occasionally simple or complex moans exhibited both FM and **pulsive** components. Aurally these calls sounded 'complex' and were so categorized for the purpose of this initial analysis. Trumpeting sounds were high frequency (800 Hz - 5000 Hz) calls that contain both FM and **pulsive** components. The sound categories presented here are comparable to those reported by Wursig et al. (1982) for **bowhead** sounds recorded in the eastern Beaufort Sea.

Fit. No.	Date	Area	Species subject	Sounds recorded	Comments
2	4/24	N. Bering Sea	bowheads	BE, BS	No BH sounds
4	4/26	s. Chukchi Sea	bowheads	BH, BE, BS	BH cow/calf; few bowhead sounds
6	4/29	N. Bering Sea	bowheads	BH , BE	
8	5/2	E. Beaufort Sea	bowheads	BH, BS	few bowhead sounds
9	5/3	E. Beaufort Sea	bowheads	BH, BS	"s" track; few bowhead sounds
10	5/4	E. 'Beaufort Sea	bowheads	BH, BE, BS	slaps
11	5/5	Beaufort Sea	bowheads	BH, ES	
16	5/13	Beaufort Sea	bowheads	BH, BE	cow/calf; cow/yr. good BE
17	5/14	W. Beaufort Sea	bowheads	BH, BE	
19	5/21	W. Beaufort Sea	bowheads	BS	

Table V. **Sonobuoy** drop locations and subject species, spring 1982.

Date	sample duration	No. bow-heads	Call rate	General behavior	CALL TYPE #(%)							noise	Comment	N
					Simple					complex				
					up	down	constant	inflect	high	growl	trumpet			
4/26	16"	28	0.08	mild social swimming	8(23)	4(11)			3(9)	16(46)	4(11)	BS, BE aircraft	cow/calf	35
4/28	22"	13	0.11	mild social swimming	7(23)	6(19)	2(6)			15(48)	1(3)	BE (100+) aircraft		31
5/2	24"	42	0.03	swimming	17(53)	3(9)	3(9)	2(6)	(13)	3(9)		BS		32
5/3	27"	42	0.06	swimming	23(36)	15(23)	6(9)	5(8)		15(23)		BS aircraft	"s" track	64
5/4	95"	27	0.10	mating high social	21(8)	25(10)	10(4)	7(3)	1(8)	118(47)	48(19)	BS, BE H ₂ O noise	slaps	250
5/5	36"	11	0.32	swimming mild social	15(12)	19(15)	4(3)	5(4)	3(2)	52(41)	29(23)	BS aircraft		127
5/13	58"	5	0.43	swimming mild social	28(22)	13(10)	12(10)	4(3)		61(49)	7(6)	BE (good)		125
5/14	35"	12	D.23	mild social	24(25)	17(18)	10(11)	8(8)		32(34)	4(4)	BE (distant)		95
				TOTAL	143(19)	02(13)	47(6)	31(4)	1(4)	312(41)	93(12)			759

BS : bearded seal
BE: belukha whale

Table VI. Results of initial aural analysis of bowhead sounds recorded in spring 1982.

Most sounds recorded in spring, especially of whales engaged in social' behavior, were complex moans. Of a sound sample containing 759 discrete calls, 53% were complex moans and 47% were simple moans. Simple moans were recorded most often from whales that were actually swimming. Many complex sounds were recorded from **sonobuoys** dropped near socializing groups of **bow-**heads in **the** spring (4 May). This is similar to impressions from past years' data, suggesting that migrating bowheads may produce fewer sounds than stationary whales and/or social groups.

A comprehensive discussion of all bowhead sounds recorded in 1982 is **provided** in the fall section of this report.

Other Species

Gray Whales (Eschrichtus robustus)

Two gray whales were seen in Block C in the northern Bering Sea on 21 May. They were swimming through broken ice (**2/10**) heading northwest and dove in response to the aircraft. Their location is incorporated in the sighting chart for summer sightings, Figure 8.

Belukha whales (Delphinapterus leucas)

In the spring, **belukha** whales were seen well ahead of, accompanying (as close as 15 m) and well behind the main group of migrating bowheads in the northern Bering and **Chukchi** Seas. The distribution of **belukha** sightings in spring is shown with the fall distribution in Figure 30. **Belukhas** were often seen actively keeping small pockets of water ice free by swimming back and forth through them. They also occasionally remained still so that new ice formed around them. The whales were evidenced after their departure by "ice domes". A "nursery" of approximately 50 adult **belukhas**, many with calves was seen 5 km south of King Island in the Bering Sea in late May.

Belukha sightings east of Pt. Barrow were generally north and east of bowhead sightings. Apparently these whales move to deeper water north of the bowhead's migration route while actively migrating in an easterly direction.

They were often seen as a continuous stream of animals in small leads, cracks, and open water pools northwest of Pt. Barrow. Belukhas were observed breaking through light grease ice to breathe. These holes in the ice made by belukhas were consistently sighted east and northeast of Pt. Barrow in May.

Over 500 belukhas, mostly adults, were sighted north of Pt. Barrow near 72°N, 155°42'W on 10 May in water about 200 m deep. This is the third year that large numbers (400-600) of belukhas have been encountered northeast of Pt. Barrow in the spring.

Narwhals (Monodon monoceros)

Two male narwhals were observed lying in 8/10 ice coverage 8 km WNW of King Island in the Bering Sea on 26 April (Figure 7). The whales were about 4 m long with 2-m tusks and of a mottled grey coloration. When first encountered they were lying still at the surface close to the ice edge facing south; they slowly turned to the north and dove under the ice.

These whales had apparently wintered in the Bering Sea and were migrating north with the bowhead and belukha whales. An Arctic whale of the same family as the belukha whale, narwhals generally move north and south seasonally with the prevailing ice coverage and are commonly found between 70°N and 80°N (Reeves and Tracy, 1980). The narwhal is generally thought to be a deep-water species relative to the more coastal belukha. The only recent record of narwhals south of our sighting is that of a stranded (live) animal on the Alaska Peninsula at 56°N, 161°W (Geist et al., 1960) in April 1957.

Pinnipeds

Walrus (Odobenus rosmarus), bearded seals (Erignathus barbatus), and ringed seals (Pusa hispida) were encountered on most flights made in spring. Walrus were commonly seen in the northern Bering and Chukchi Seas but rarely in the Beaufort Sea. A peak sighting of over 2000 animals near King Island in the Bering Sea was made on 25 May.

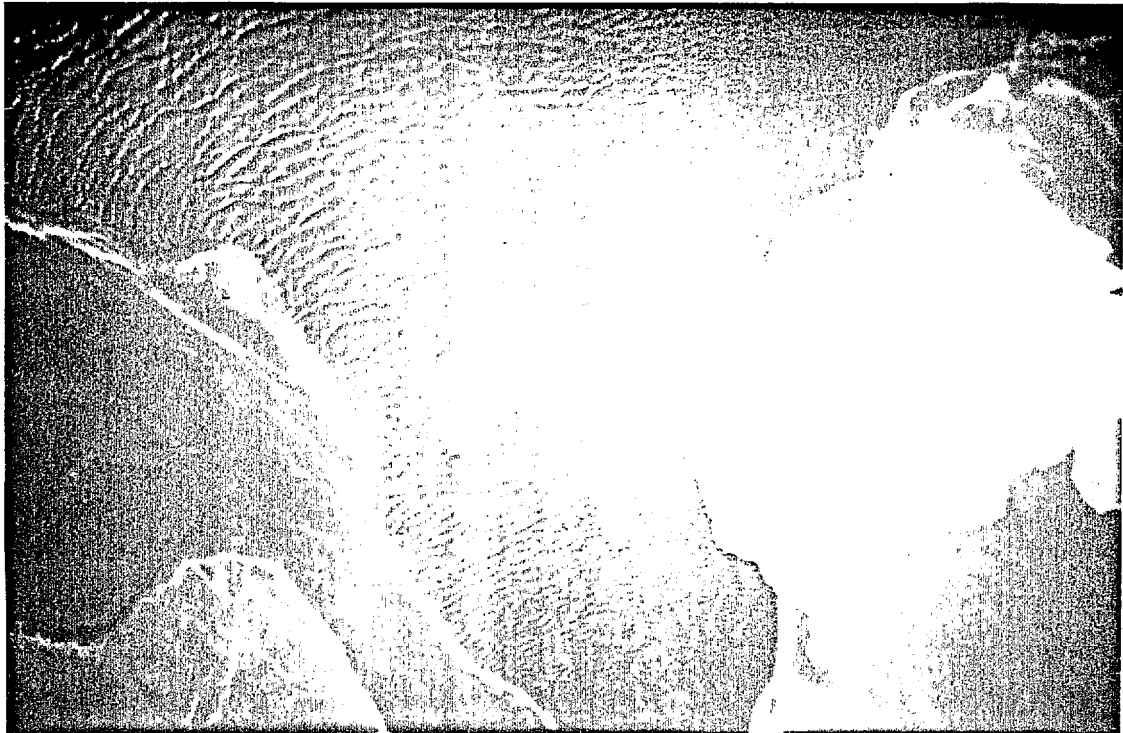


Figure 7. The first record of a sighting of live narwhals in the offshore water of the Bering Sea; two males near King Island, 26 April 1982.

Bearded and ringed seals were usually seen in the Beaufort and Chukchi Seas in spring. Bearded seals were often lying along cracks in the ice, while ringed seals were found near holes they had maintained in the ice. Calving and pupping were observed in May in the Bering Sea as indicated by blood stains on the ice.

Polar Bears (*Ursus maritimus*)

Two polar bears were seen in the spring. One, seen on 2 May (Flight 8), was approximately 60 km north of Smith Bay (71°28.5'N, 154°19.7'W); the second seen on 21 May (Flight 19) was approximately 50 km NNW of Demarcation Bay (69°54.9'N, 141°57.2'W).

SUMMER (JULY)

Survey Effort and Rationale

In July, line transect surveys were flown in blocks C, G and H, and 4 flights were made over the **Chirikov** Basin extending roughly between St. Lawrence Island and Bering strait (Flights 24 to 27). These latter flights were in support of an MMS/OCSEAP-funded* gray whale feeding study conducted by LGL Ltd. Environmental Research Associates. Our surveys of the area (since 1981) have been designed to determine the distribution, relative abundance and, to the extent possible, the gross behavior and movement of gray whales.

Gray Whale Distribution, Relative Abundance, and Behavior

A total of 320 gray whales and 8 gray whale carcasses were sighted between St. Lawrence Island and Pt. Barrow in July. Twenty-six gray whales were seen in the northeastern **Chukchi** Sea from 28 September to 11 October and are discussed in the "fall" section of the report. Figure 8 shows the distribution of all gray whale sightings in the northern Bering and **Chukchi** seas in 1982. Apparent areas of concentration included: near the southeastern and southwestern coast of St. Lawrence Island; a portion of the Chirikov Basin northwest of King Island; an area just off Cape Lisburne; and one area extending roughly from **Wainwright** to the southern end of Peard Bay. This distribution is generally similar to that seen in previous years (Moore and **Ljungblad**, 1983).

Gray whale density estimates for regions in the northern Bering and **Chukchi** Seas are presented in Appendix B. When comparing density estimates between years for this region it should be noted that the area was surveyed throughout May, June and July in 1981, while the 1982 efforts were confined to

*OCSEAP = Outer Continental Shelf Environmental Assessment Program, **NOAA**, us. Department of **Commerce**.

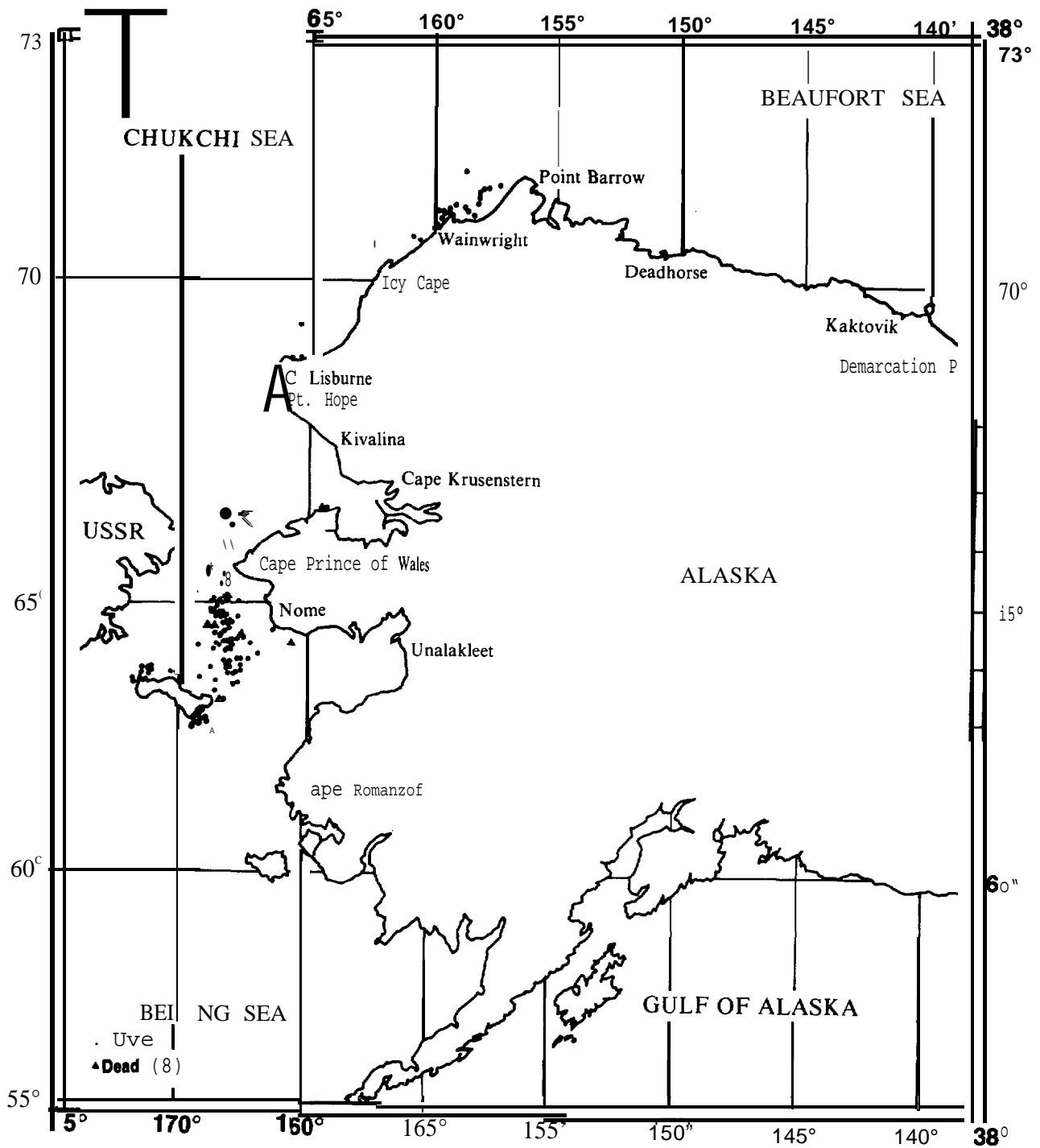


Figure 8. Distribution of all gray whale sightings in the northern Bering and Chukchi Seas representing 348 whales. Locations of 8 gray whale carcasses are denoted by a triangle (▲).

the last half of July. Thus, differences in 1981 and 1982 density data may be partially due to intraseasonal variations.

Gray whales were seen from 5 m to 140 km from shore in water ranging from 4 m to 40 m deep. At times, whales observed near the coasts appeared to be resting on the bottom. One cow-calf pair was seen apparently lying on the bottom just off Cape Nome (Flight 28).

Gray whales that were sighted with mud plumes were assumed to be feeding. Mud plumes are large billows of sediment that in calm waters (**Beaufort** 00 to 02) may retain their identifiable shape and subsurface discoloration for **5-10** minutes and thus are excellent sighting cues (Figure 9). Mud plumes also attract feeding birds (Harrison, 1979), which aids sightability. Gray whales often were sighted soon after we started seeing plumes. Thus, plume-only sightings were recorded this year, and though they are not included in our distributional or density data, we feel they are good indicators that gray whales were present.

Overall, 45% (n = 320) of the gray whales observed were feeding. Of the gray whales seen in the **Chirikov** Basin, 48% (n = 199) were feeding. In **May-July** 1981, approximately 63% (n = 318) of the gray whales seen in the Chirikov Basin were associated with mud plumes. This comparison suggests that gray whale utilization of specific feeding areas may be more variable within or between years than previously assumed.

Annual differences **and/or intra-seasonal** variation may also account for the surprising number (32% of all grays seen) of grays encountered off Cape Lisburne and between **Wainwright** and Peard Bay on 31 July. These whales **probably** moved north through the Bering Strait sometime between late May (when only two gray whales were observed near St. Lawrence Island, Flight 21) and early July (when we began our surveys). No net northward movement was evidenced by gray whales we saw in the southern **Chukchi** Sea or the Chirikov Basin area

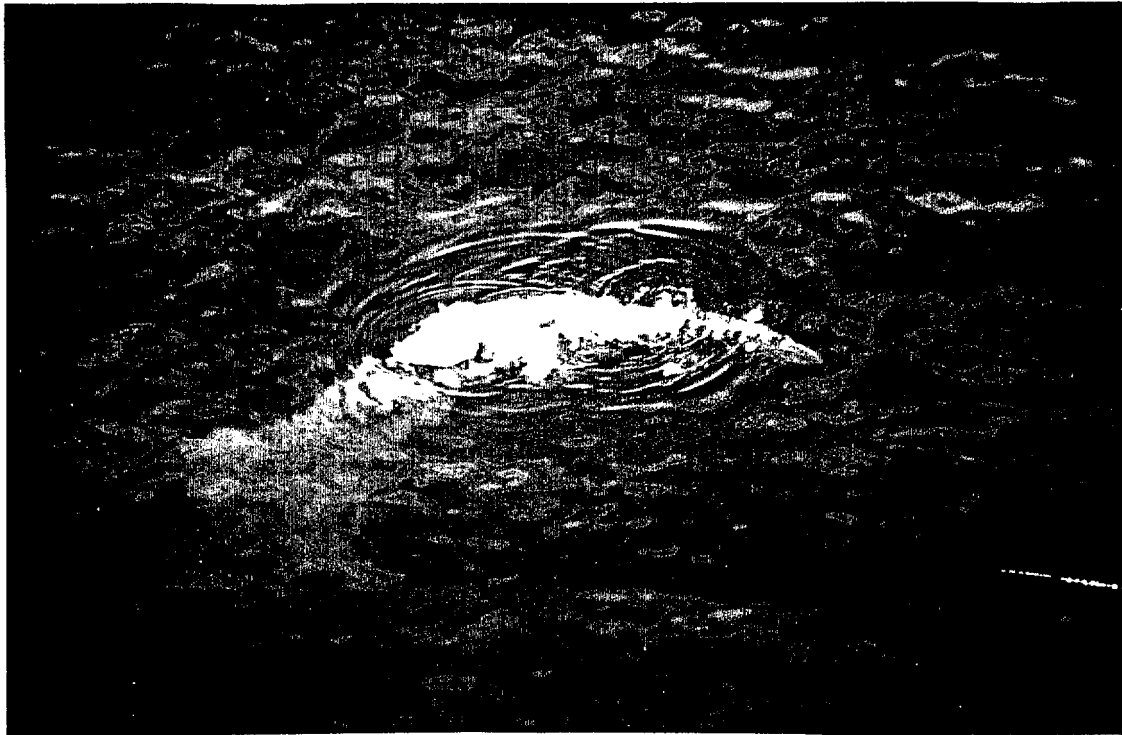


Figure 9. Gray whale mud plume usually indicative of feeding whales

during July. The headings of gray whales sighted during four transect surveys in blocks C, G, and H are presented in Table VII. The gray whales in block C **exhibited** headings in all directions ($\bar{X} = 9.0$, $p < .50$, $n = 23$), while the headings of those whales in blocks G and H were significantly clustered about 226°T (**Laubscher-Rudolph** $R=170^\circ$, $n = 11$, $p < .005$).

Thirty-eight percent ($n = 111$) of the gray whales encountered from Cape Lisburne north on our 31 July coastal survey were feeding. This also contrasts with June-July 1981 data, where none of the gray whales seen north of 69°N latitude were feeding; all were resting or swimming. While major gray whale feeding areas have been documented in the northcentral and northwestern Bering Sea, as well as the southwestern **Chukchi** Sea (**Votrogov** and **Bogoslovskaya**, 1980; **Bogoslovskaya** et al., 1981), there generally has been a noticeable absence of evidence of feeding in coastal areas on the eastern side of the Bering and **Chukchi** Seas. Such feeding patterns are consistent with the report by Stoker (1981) regarding the lack of benthic infauna in the eastern Bering/Chukchi continental shelf. Variable current flow through the Bering Strait possibly caused a change in the benthic community this year, thus possibly yielding an abundant infauna along the northeastern **Chukchi** Shelf.

Whales that were not feeding this year were swimming very slowly (less than 1 km/h) in all directions, or resting. Several underwater blows by whales rising vertically in the water column to breathe were observed. **Sono-**buoys were dropped near gray whales off Southeast Cape, St. Lawrence Island on 24 July (Flight 30) and near gray whales (including calves) off Point Lay on 31 July. No sounds were recorded on either date.

Gray Whale Calves

Of 320 gray whales seen, 19 were calves, for a gross annual recruitment rate (**GARR**) of 5.94% (number of calves/total number of whales). On 31 **July**, 18 of the 111 whales sighted (16%) were calves. This was the highest gray whale calf count on any one day or area that we have encountered. The cow-calf pairs were in close proximity (within 5 m) and in some cases nearly touching.

Date	Fit.	N. Bering Sea: Block C (n = 23)	Date	Fit.	S. Chukchi: Block G, H (n= 11)
7-19	29	270° 150° 150° 180° 180° 340° 030° 190° 040° 240° 240°	7-18	28	2600 230° 180° 180° 210° 250° 240° 240°
7-24	30	330° 330° 260° 210° 3600 230° 270° 2600 250° 120° 080° 250°	7-30	31	250° 160° 0900

Table VII. Gray whale headings in the northern Bering (block C) and southern **Chukchi** (blocks G and H) Seas.

These pairs consistently responded to the aircraft, though we remained at 335 m altitude or higher throughout our observation. When the aircraft overflew a cow-calf pair, the adult would move over the calf, or the calf would swim under the adult, such that the calf was nearly totally hidden (Figure 10). This response was seen each time the aircraft was near a cow-calf pair and suggests that some hidden calves may have not been counted.

In July, gray whales with calves appeared to be a geographically separate group. Eighteen calves were among the 111 gray whales distributed between Cape Lisburne and **Wainwright**, while only 1 calf was seen in a total of 209 whales sighted between St. Lawrence Island and 50 km southwest of Pt. Hope. There was roughly a 150 km separation between the first sighting of the group of 111 gray whales seen on 31 July and our most northerly gray whale encountered prior to that date.

While a possible increase in prey availability (for which the only evidence is the presence of the feeding whales) accounts for the presence of increased numbers of gray whales along the northeastern **Chukchi** Sea coast, it does not explain the high calf count observed there. Segregation of cow calf and/or female groups in gray whales in northern latitudes has not been documented as a common occurrence as, for example, it has in sperm whales, Physeter macrocephalus (Best, 1979). Such segregation in feeding gray whale groups may be an extension of a segregation found in migrating grays. "The migration is in fact a procession of gray whales segregated according to age and sex. Females with calves apparently travel [in spring] farther offshore than the rest of the herd." (Sumich, 1976, p 233-34). If this segregation trend continues it would not be surprising to find large numbers of cows with calves, and possibly other adult females, together on the feeding grounds.

Responses to Aircraft

Gray whales were seen on 9 flights, but responses to the aircraft were observed on only 5. For all age/reproductive classes, 102, or 32% (n = 320) of the gray whales encountered responded to our aircraft (Table VIII).

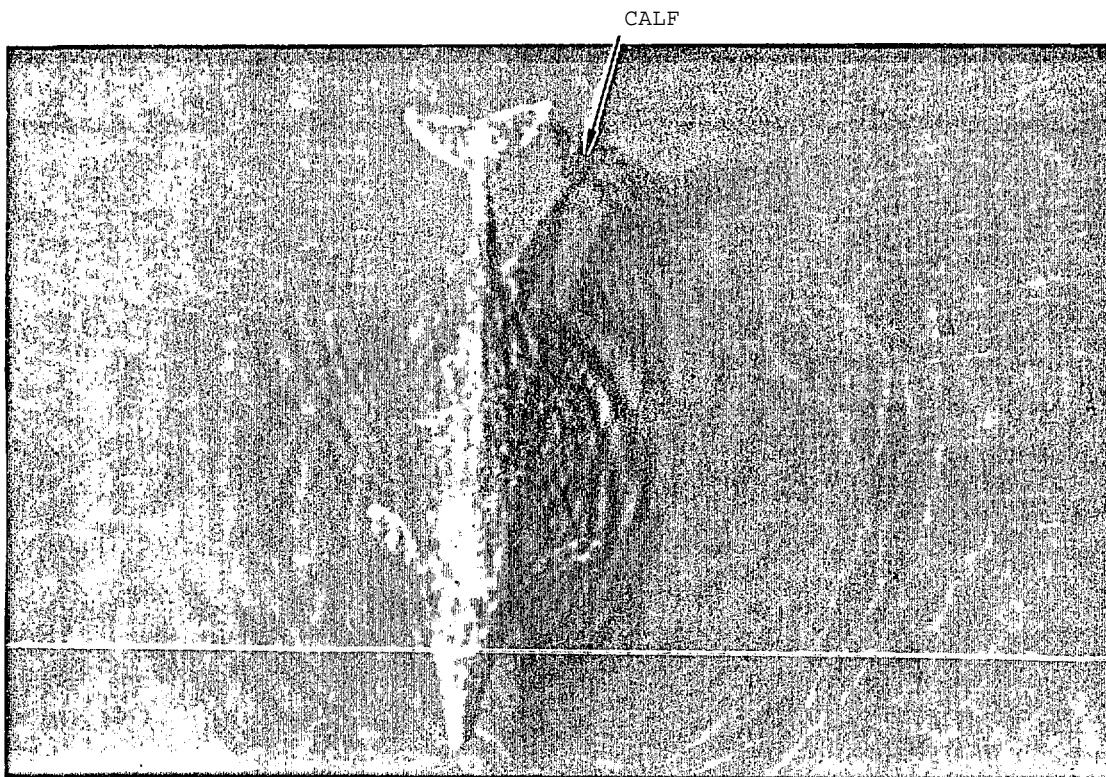


Figure 10. Gray whale calf partially hidden by adult whale in response to aircraft, 31 July 1982.

The response of gray whales to our aircraft was most dramatic when calves were present as previously discussed. In these samples, 73% ($n = 120$; Flights 28 and 32) responded. In gray whale sightings where no calves were present, likely responses were observed for 15% ($n = 99$; Flights 29-31) of all whales when the aircraft was at 305 m altitude.

	No. observed #T/#C	No. responses #T/#C	% of total response
Flight 28	9/1	2/1	22
Flight 29	54/0	8/0	15
Flight 30	42/0	6/0	14
Flight 31	3/0	1/0	33
Flight 32	111/18	85/18	77
Total grays on response flights	219	102	47
Total grays/season =	320	102	32

Table VIII. Gray whale responses to aircraft on 5 of 9 flights where response was seen. Average altitude 305 m. #T = total number, #C = total calves.

Injured Gray Whales and Carcasses

A gray whale observed on 31 July was listing to its right side and appeared sick or injured, although no wounds or disfigurements were seen. This whale was within 0.25 km of the beach north of Wainwright (70°48.4'N, 159°37.5'W) and in water 3 to 5 m deep. As we flew over, the whale thrashed the water with its flukes, but these motions appeared to be ineffective in moving it. When we left the area this whale was still on its side in very shallow water.

Eight gray whale carcasses were observed either floating or beached on shore in the northern Bering and Chukchi Seas. Their positions are listed in Table IX and shown in Figure 8. Two of the carcasses seen floating north of St. Lawrence Island appeared to have part of their heads and lower lips torn away, possibly as a result of killer whale (Orcinus orca) predation. A chase sequence of gray whales by killer whales was observed in waters north of St. Lawrence Island in 1981 (Ljungblad and Moore, 1983 in press). The cause of

Date	Fit. No.	No.	Position	Comment
July 11	25	1	64°24.9'N, 167°41.5'W	Floating
July 12	26	1	63°14.5'N, 168°37.2'W	Floating, head wounds
July 15		1	64°22.9'N, 165°49.4'W	Floating, 10 m long, lower lip torn away
July 19	29	1	66°35.4'N, 164°08.7'W	Beached
		1	64°45.2'N, 68°42.6'W	Floating, 13 m long
July 23	*	1	62°44.6'N, 68°44.8'W	Floating, 6.5-7 m long
July 31	32	1	68°21.2'N, 66°37.2'W	Beached
		1	68°39.7'N, 166°14.8'W	Beached

*ADFG - Alaska Department of Fish and Game sighting

Table IX. Locations of gray whale carcasses, (N=8).

mortality for the remaining six carcasses can not be speculated. The carcasses seen on the beach had reached an advanced stage of decomposition.

Other Species

Belukha whales (Delphinapterus leucas)

Three **belukha** whales were seen close together off the southeast coast of St. Lawrence Island on 24 July. These whales were swimming away from the island and dove in apparent response to the aircraft. One **belukha** carcass was observed on the beach north of Shishmaref on 19 July at 66°34.6'N, 163°46.1'W.

It is not presently known what portion of the Bering Sea population of **belukha** whales migrates from the Bering Sea, through the Bering Strait, and **Chukchi Sea**, and into the Beaufort Sea. Though we saw only 3 **belukha** in the Bering Sea in July of 1982, over 130 **belukhas** were seen feeding near the Yukon River delta in July of 1981. The population of **belukhas** that occurs within

the Bering Sea appears to be composed of resident and migratory groups. The Alaska Department of Fish and Game reports a resident stock of 1,000-1,500 belukhas occurs in the Bristol Bay-Kuskokwim Bay area year around (Klinkhart, 1966). Unknown numbers of belukhas apparently overwinter in the Bering Sea north of Bristol Bay (Fay, 1974). Most of these animals probably migrate north with the bowheads as the ice recedes in the spring, while a portion of this subgroup remains in the Yukon Delta region or Kotzebue Sound area.

Minke whale (Balaenoptera acutorostrata)

One minke whale was seen by an LGL observer in the northern Bering Sea at 65°51.9'N, 169°09'W on 11 July. The minke was swimming southwest but was not resighted. Minke whales have been seen in these waters in previous years.

Unidentified cetaceans

One unidentified cetacean was seen in block H on 30 July. This whale may have been a gray, but only the blow and part of the head were seen 3-4 km from the plane and the whale could not be positively identified.

Pinnipeds

Pinnipeds were seen on every flight in July except Flight 28 in blocks G and H. Except for two bearded seals that remained at the surface, nearly all seals encountered in open water dove in response to the aircraft and were recorded as "unidentified pinnipeds." Notably, there were many seals, as well as about 100 live walruses (on ice floes) north of Wainwright in the same general area as the already mentioned concentration of gray whales seen on 31 July. The count of pinnipeds and walruses was probably low on that day because we were concentrating our efforts on the gray whales.

Walrus carcasses were seen floating nearshore and on the beaches from Nome to Barrow in July. Approximate counts of beached carcasses by area are presented in Table X. Areas of concentration included the northern Seward Peninsula, Baldwin Peninsula, and the coastline from Shesualek to Cape

Lisburne. We also saw many floating walrus carcasses near King Island and several in block H that are not represented in Table X. A large proportion of the dead walruses had been decapitated.

Fit. No.	Coastline	Number
28	S. Seward Peninsula	7
29	N. Seward Peninsula	171
31	Baldwin Peninsula	39
32	Cape Krusenstern - Pt. Barrow	62

Table X. Beached walrus carcass count* (**n=279**).

*Approximate count only. observer priority always given to **live** animals.

FALL (AUGUST, SEPTEMBER, OCTOBER)

Survey Effort and Rationale

Line transect and search surveys were flown in the Beaufort Sea between 2 August and 17 October. In August and early September, surveys were concentrated in the eastern U.S. Beaufort Sea, in anticipation of intercepting the westward bowhead migration. Transect surveys were flown in blocks 4 through 9 in August and early September and distributed between 1 through 12 in mid to late September. Often, several adjoining blocks were flown successively, if one block was east or west of another, or combined, if one block was north or south of another.

In early September, concurrently with **this** study, MMS implemented a plan to regulate seasonal drilling on the outer continental shelf lease areas. This plan, developed in consultation with National Marine Fisheries Service (NMFS), required a daily flow of information from the survey team to appropriate MMS and NMFS authorities throughout September. Thus, on a daily basis, data on location of survey efforts; weather and ice conditions; and whale sightings, behavior, and headings were conveyed as requested. In addition, information obtained from the surveys was communicated directly to the scientific team monitoring the interaction of whales and geophysical vessels (N642).

Flight effort in October, was concentrated in the western half of the Alaskan Beaufort Sea and the northern Chukchi Sea to monitor the bowhead migration as it moved along the Alaskan Coast. Line transect surveys in blocks 1, 3, 11, 12, and M were flown (Flights 76-87). One flight was completed in block 6, as well as a search survey in the MacKenzie Bay-Herschel Island area. This effort was designed to assess the distribution and relative abundance of bowhead whales during the latter part of their fall migration across the Beaufort Sea and into the Chukchi Sea. From 6 to 15 October, N642 flew transect surveys also to obtain general distributional information and augment coverage of the Beaufort Sea to the east (Flights 88-94).

Weather conditions often determined which blocks were surveyed, where transects legs were truncated, and when flights were curtailed. On occasions when complete transect surveys could not be flown due to fog, the aircraft was flown along the edge of the fog to assess the ice coverage or to search for whales. During the 78-day fall season, we did not fly a total of 28 days (35.9%): 21 (26.9%) due to weather, 4 (5.1%) due to aircraft maintenance, and 1 (1.3%) because the aircraft was on loan to the polar bear tagging project. Also, the pilots required 2 rest days.

Other factors also hampered flight efforts. The requirement of an adequate fuel reserve on landing (for use if an alternate landing site was chosen due to weather) shortened some surveys. Darkness limited five flights, and the closing of the principal airstrip (Barter Island) limited one. Throughout the surveys, the aircraft attempted to avoid all whaling activity and areas where hunting may have been taking place.

Survey Conditions Summary

Ice conditions in the Beaufort Sea remained heavy into early August. A narrow 1- to 5-km band of open water extended from the shore north to an ice field of 7/10 to 9/10 coverage. Most ice near the shore (south of 70°30'N latitude) in early August was old, broken shorefast ice and was often dirty and broken into pieces smaller than 50 m on the longest axis. Ice north of 70°30'N latitude appeared to be less fragmented. Large pieces of pancake ice, up to 300 m wide, were not uncommon. Up to 9/10 coverage of new ice was common in areas surveyed north of 70°30'N latitude.

By mid-August, ice conditions began changing rapidly. The ice was melting and being moved dramatically from day to day by both winds and currents. Extensive open water east of 140°W longitude and patches or swaths of open water near 70°30'N latitude were observed. Ice coverage of greater than 9/10 was present north of 72°N latitude but contained open areas as wide as 1 km. These rapidly changing ice conditions were exemplified by the fact that on 16 August at 70°30'N latitude between longitude 140°W and 143°W there was 9/10 coverage, while on 21 August this area was ice free and open.

In September the ice continued to move and melt. The eastern Beaufort Sea contained areas of heavy (7/10 - 10/10), medium (4/10 - 6/10) and light (1/10 - 3/10) ice coverage and some open water (Figure 11), and the inside of the barrier islands was completely clear of ice by 4 September. There were some small patches of loose broken shorefast ice 1 to 2 km wide west of Barter Island, but no shorefast ice remained between Barter Island and Deadhorse. Some small pieces of multi-year ice were seen north of 72°N latitude between 140°W and 144°W longitude.

By the end of September, most of the Beaufort Sea ice had melted or blown north so that open water stretched beyond the horizon at 72°N latitude as observed from 300 m altitude. However, on calm mornings grease ice accumulated and was noted near the mainland in the Smith Bay and Camden Bay areas and an approximately 10-km-wide strip of broken new ice was present east of Pt. Barrow.

Offshore ice conditions in the Beaufort Sea remained relatively open through 3 October. However, by 4 October the nearshore ice cover was estimated to be 9/10 in Smith Bay and the shallow areas of Harrison Bay. New grease ice and broken pancake ice of 7/10 to 8/10 coverage extended approximately 70 km offshore north of Harrison Bay. On 5 October, ice coverage was estimated to be 7/10 between 71°50'N and 72°00'N latitude in the western Beaufort Sea, while a 1- to 2-km-wide lead remained nearshore at about the 20-m isobath. By 9 October ice cover was 8/10 to 10/10 between Smith Bay and Pt. Barrow in the Beaufort Sea. In the Chukchi Sea ice cover was 8/10 to 10/10 between Pt. Barrow and Wainwright, decreasing to approximately 4/10 directly off Wainwright, then increasing to 7/10 to 8/10 south to Pt. Lay. On 10 October, ice cover was 9/10 to 10/10 from Pt. Barrow to Harrison Bay out to 71°20'N latitude. Observations of ice conditions in the Beaufort Sea between 10 and 15 October are summarized in Figure 12. After 9 October, ice coverage in the Beaufort Sea remained 8/10 to 10/10. However, wind that shifted the ice caused daily changes in the positions of cracks and openings, primarily along the 20-m isobath.

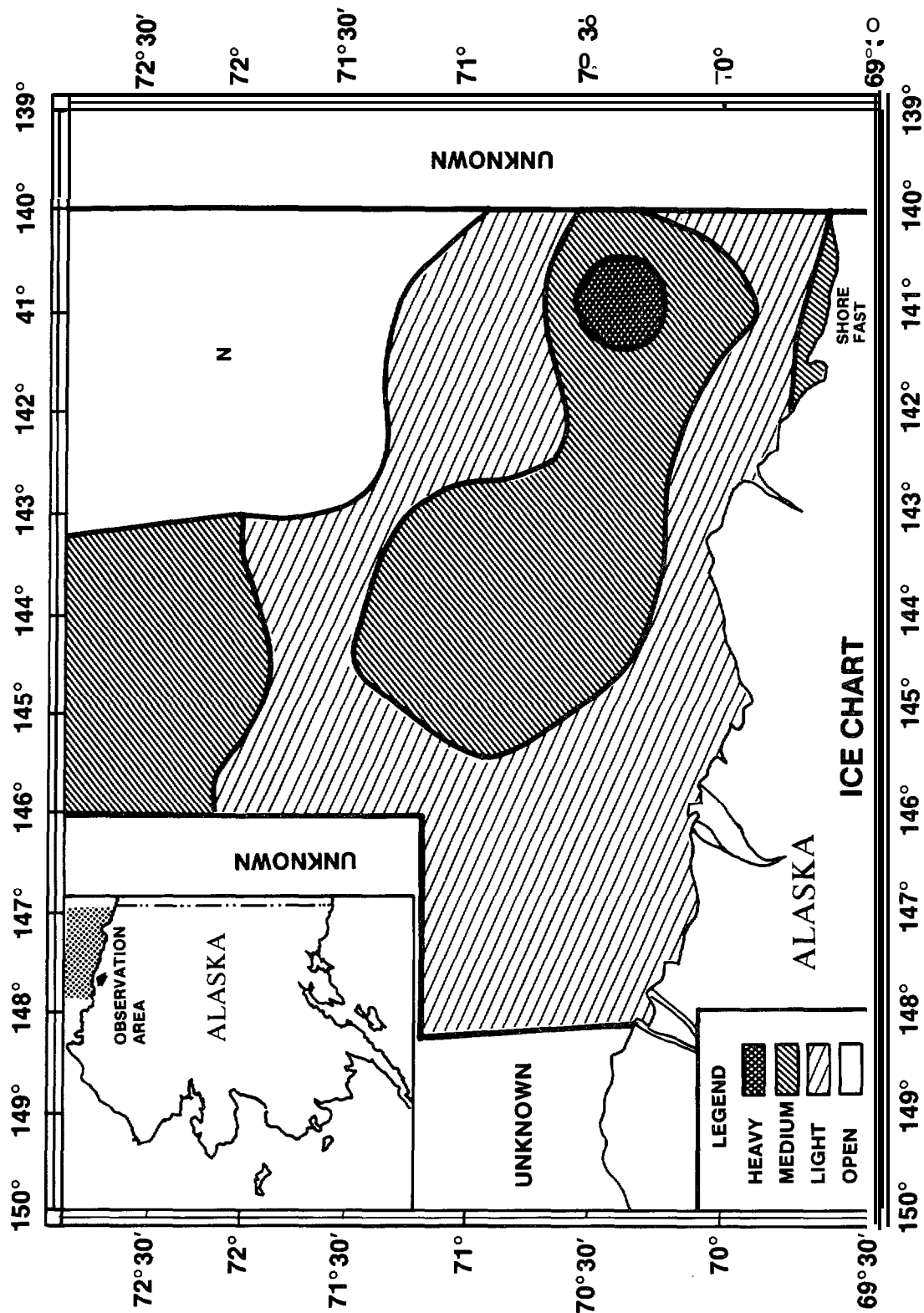
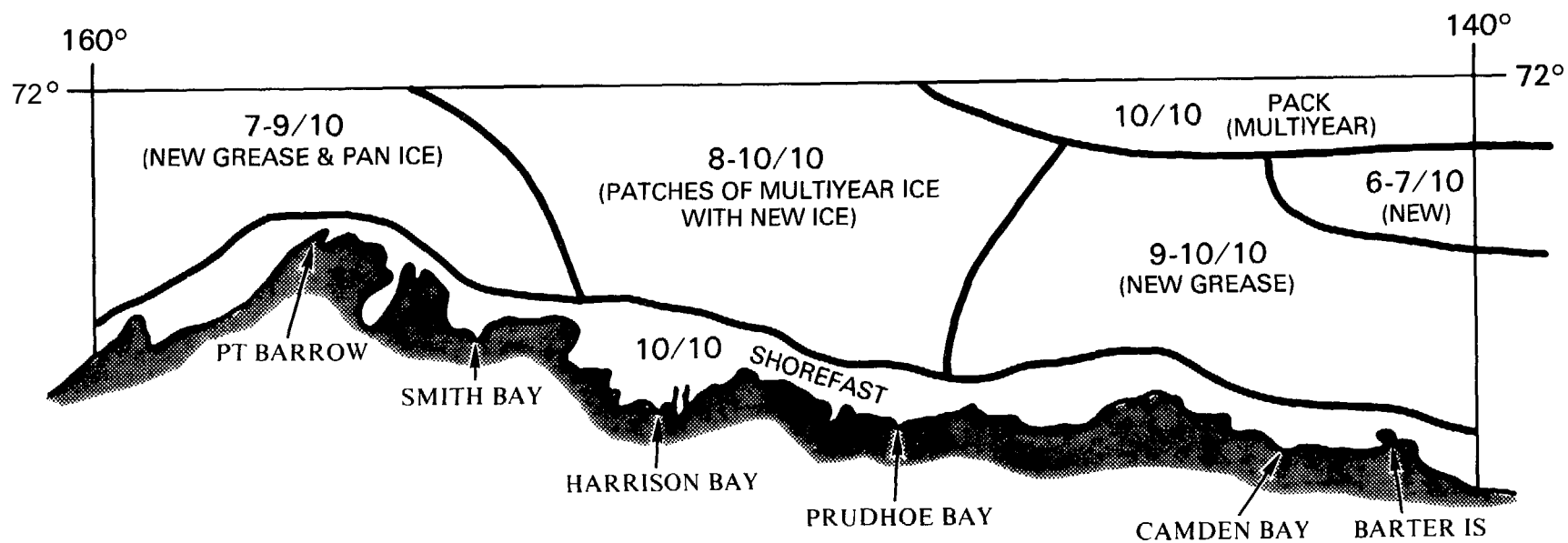


Figure 11. Ice conditions in the eastern Beaufort Sea in early September 1982.



ICE COMPOSITE — 10-15 OCT 1982

Figure 12. Ice conditions in mid October, 1982 after freeze-up began.

Sea states during fall surveys ranged from a Beaufort sea state 01 (light ripple, wind 1-6 knots) to 08 (high waves, foam, wind 39-46 knots) but averaged 03 (scattered whitecaps, wind 11-14 knots) to 05 (many whitecaps, wind 19-24 knots). Sea states averaged Beaufort 05 to 07 (foam, wind 28-33 knots) on Flights 74 and 75 in the Beaufort Sea.

Distribution and Relative Abundance

Line transect surveys flown in blocks 1 through 12 and M from 1 August through 17 October provided the bowhead distributional data depicted in **Figure 13**. Overall 1, 222 sightings of 490 bowhead whales were made during our transect surveys. This includes two sightings of four bowheads made by the survey crew on N642 (see Flights 88-94). In August (Figure 13-black) bowheads were primarily found approximately 50 to 200 km offshore in blocks 6-9. A few bowheads were also found near the shore along the eastern edge of block 5. In September, (Figure 13-red) most sightings were between 30 and 75 km from shore. By October (Figure 13-green) sightings were more evenly distributed away from land as the bowheads entered the Chukchi Sea and headed southwest. The distance from shore of sightings is shown for each month in Figure 14. Overall, 64% of our fall sightings were 20 to 50 km offshore, or roughly between the 10-m and 60-m isobaths.

Ice coverage did not limit the whales' distribution in fall (Table XI). In early August 82% (n = 88) of the whales were found in 7/10 to 10/10 ice coverage and 6% (n = 6) were found in 0/10 to 3/10 ice coverage. All whales in September were found in light ice coverage or open water even though heavy ice coverage still existed offshore. They were found more in heavy ice (63.6%, n = 28) in October as freeze-up occurred.

Table XII and Figures 15 through 18 summarize the number of flights made, total flight hours, the number of bowheads seen and the sightings per unit effort (**SPUE**) for **each** block, by month. The blocks are (roughly) delineated **bathymetrically** as being shallow, transitional, or deep. The highest bowhead count in August was in blocks 6 and 7 (Figure 15). In September most sightings were in nearshore blocks with the highest count occurring in block 5,

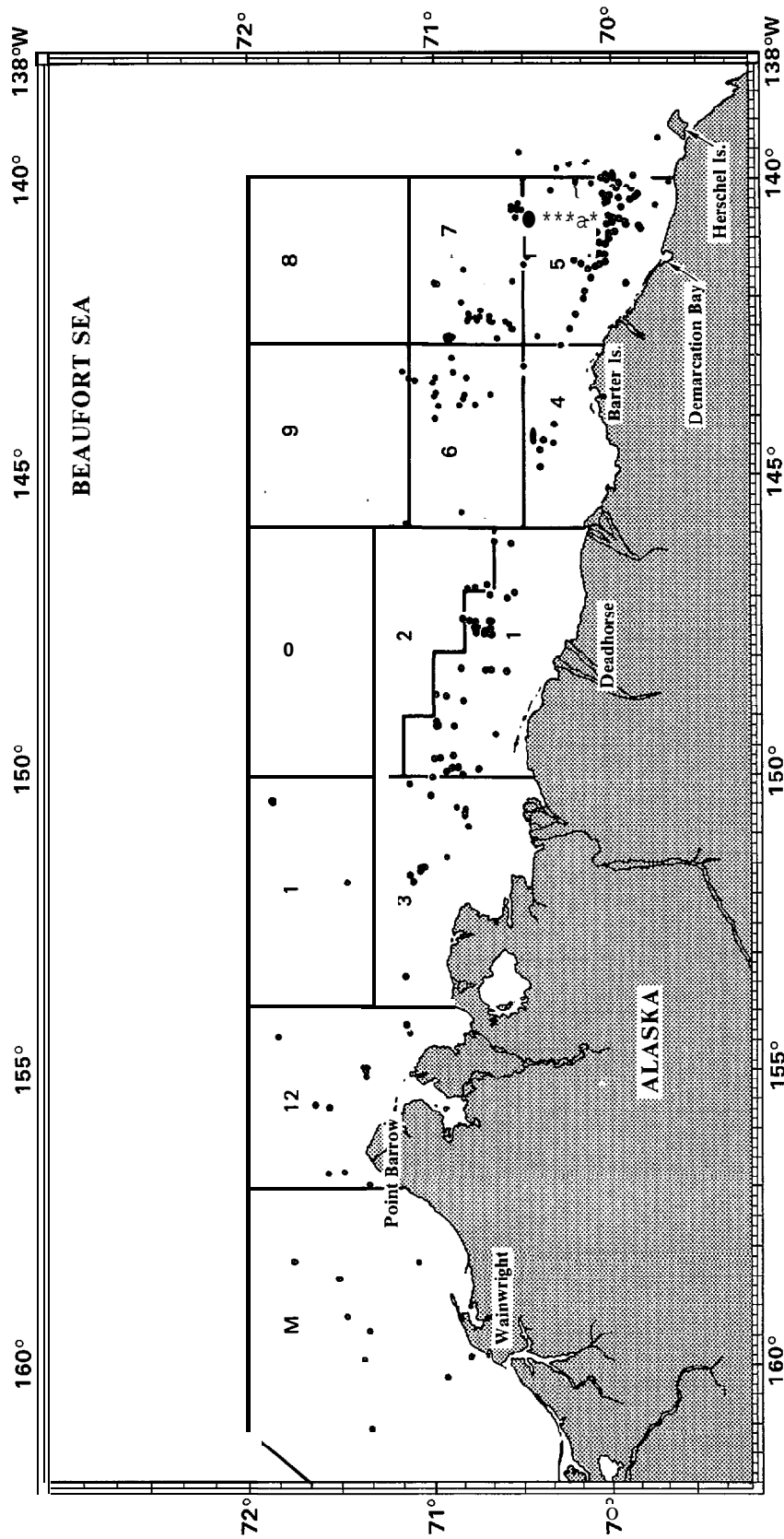


Figure 13. Overall distribution of 222 sightings of 490 bowhead whales seen between 2 August and 17 October 1982.

Black = distribution of 79 sightings of 145 bowheads, August 1982.
 Red = distribution of 114 sightings of 297 bowheads, September 1982.
 Green = distribution of 29 sightings of 48 bowheads, October 1982.

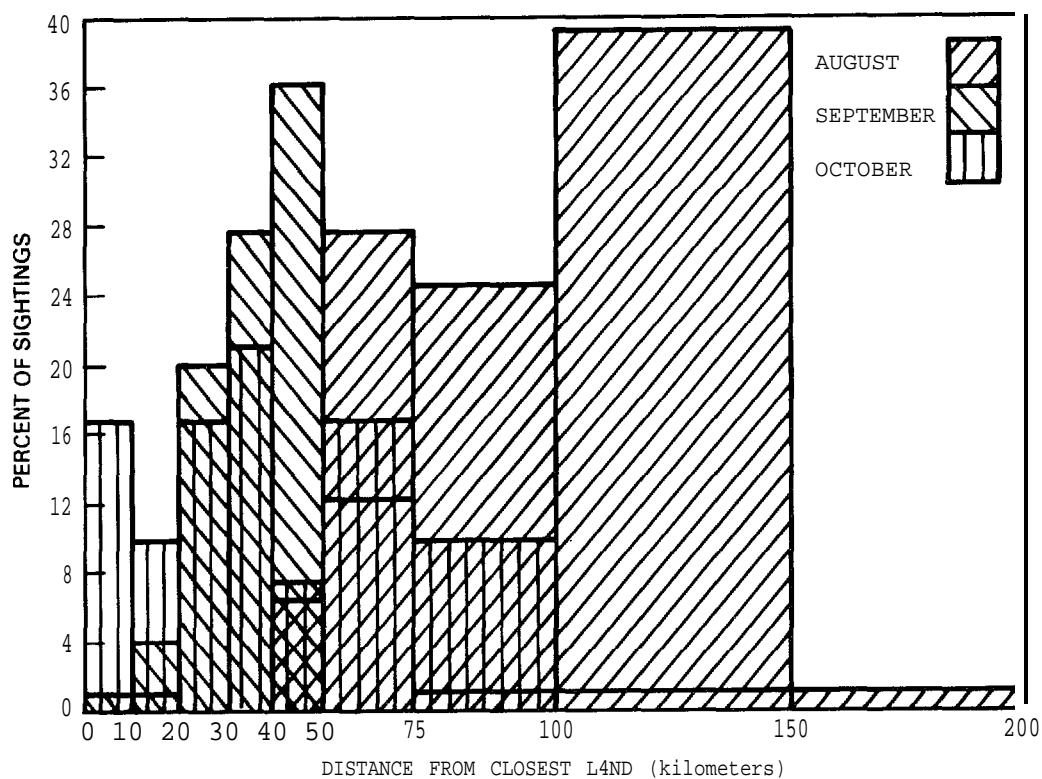


Figure 14. Bowhead sighting distance from shore, fall 1982.

ICE COVERAGE	1-15 August	16-31 August	1-15 September	16-30 September	1-17 October	Overall Fall
Heavy $\frac{7-10}{10}$	88/81.5	16/43.2	0/0	0/0	28/63.6	132/26.9
Medium $\frac{4-6}{10}$	14/13.0	15/40.5	0/0	0/0	2/4.5	31/6.3
Light $\frac{0-3}{10}$ and Open	6/5.5	6/16.2	54/100	247/100	4/3.8	327/66.7
TOTAL	08/100	37/100	54/100	247/100	44/100	490/100

Table XI. Summary of ice coverage at sightings #/%, fall 1982.

Block No.	Depth Zone	AUGUST				SEPTEMBER				OCTOBER				TOTAL			
		Flights	Hours	Bow-heads	SPUE	Flights	Hours	Bow-heads	SPUE	Flights	Hours	Bow-heads	SPUE	Flights	Hours	Bow-heads	SPUE
1	shallow	5	7.5	0	0	3	8.5	96	1.29	5	8.25	1	0.12	13	24.25	97	4.00
2	Trans	3	4.5	0	0	1	1	1	1.0	0	0	0	0	4	5.5	1	0.18
3	Shallow	0	0	0	0	6	8.5	12	0.65	3	4.25	9	2.12	9	22.75	21	0.92
4	Shallow	8	16.25	0	0	4	3.25	1	0.08	6	9.25	3	0.32	18	38.75	4	0.10
5	Shallow	6	18.75	22	1.17	7	0	8.0	9.0	6	12.75	6	0.47	19	51.5	208	4.04
6	Trans	8	16.75	31	1.85	3	6.5	0	0	2	3.75	0	0	13	27.0	31	1.15
7	Trans	9	15.75	90	5.71	1	3	0	0	0	0	0	0	10	18.75	90	4.80
8	Deep	1	2	0	0	1	2	0	0	0	0	0	0	2	4	0	0
9	Deep	1	3	2	0.67	1	3	4	1.33	0	0	0	0	2	6	6	1.0
10	Deep	0	0	0	0	0	0	0	0	1	1.75	0	0	1	1.75	0	0
11	Trans	0	0	0	0	2	4.5	0	0	3	7.25	7	0.96	5	11.75	7	0.60
12	Shallow	0	0	0	0	1	3.0	2	0.67	2	4.5	5	1.11	3	7.5	7	0.93
	Trans	0	0	0	0	1	3.25	1	0.31	2	5	4	0.80	3	8.25	5	0.61
M	Shallow	0	0	0	0	1	1.5	0	0	5	5.25	10	1.90	6	6.75	10	1.48
	Trans	0	0	0	0	0	0	0	0	5	12.0	3	0.25	5	12.0	3	0.25
Total	Shallow	19	42.5	22	0.52	22	4.75	291	4.49	27	44.25	34	0.77	68	151.5	347	2.29
Total	Transit:	1 20	37.0	121	3.27	8	8.25	2	0.11	12	28.0	14	0.50	40	83.25	137	1.64
Total	Deep	2	5.0	2	0.40	2	5.0	4	0.80	1	1.75	0	0	5	11.75	6	0.51
GRAND	TOTAL	41	84.5	145	1.72	32	18	297	3.37	40	74	48	0.64	113	246.5	490	1.99

Table XII. summary of effort, sightings and sightings per unit effort (SPUE) for each survey block by month, fall 1982.

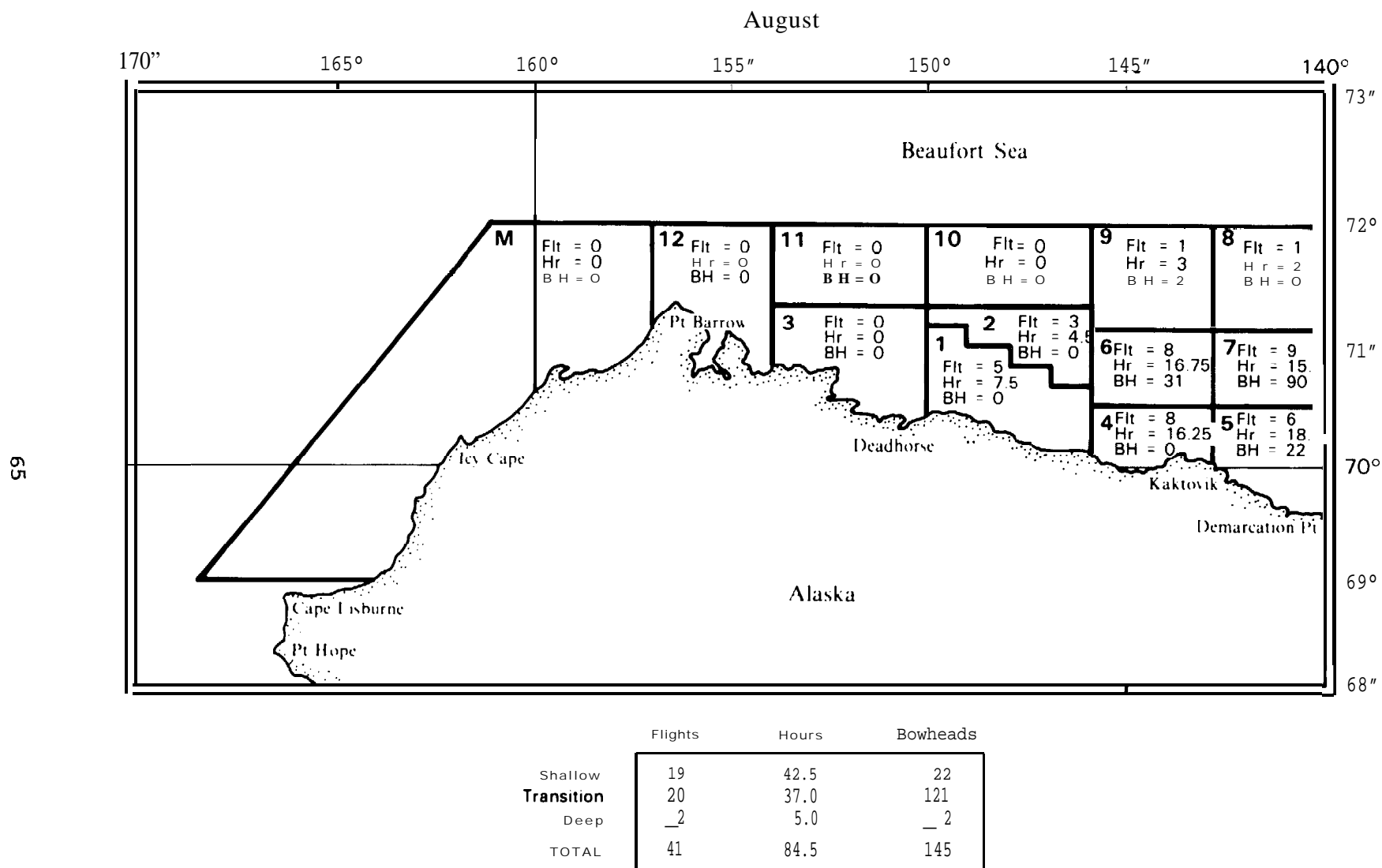
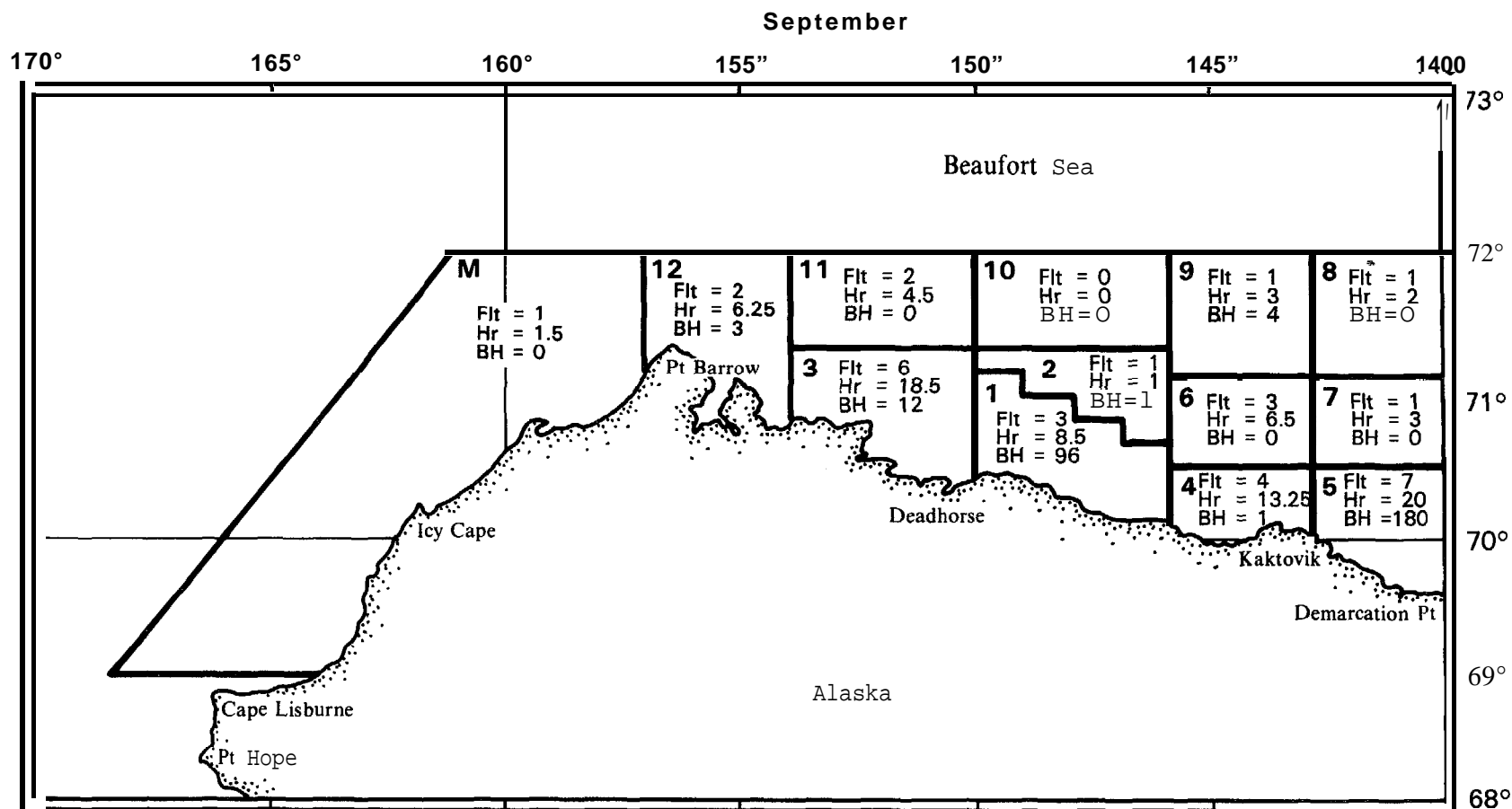


Figure 15. Flight effort and sighting summary by survey blocks#1-12 in the Beaufort Sea and block M in the Chukchi Sea, August 1982.



	Flights	Hours	Bowheads
Shallow	22	64.75	291
Transition	8	18.25	2
Deep	2	5.0	4
TOTAL	32	88.0	297

Figure 16. Flight effort and sighting summary by survey blocks#1-12 in the Beaufort Sea and block M in the Chukchi Sea, September 1982.

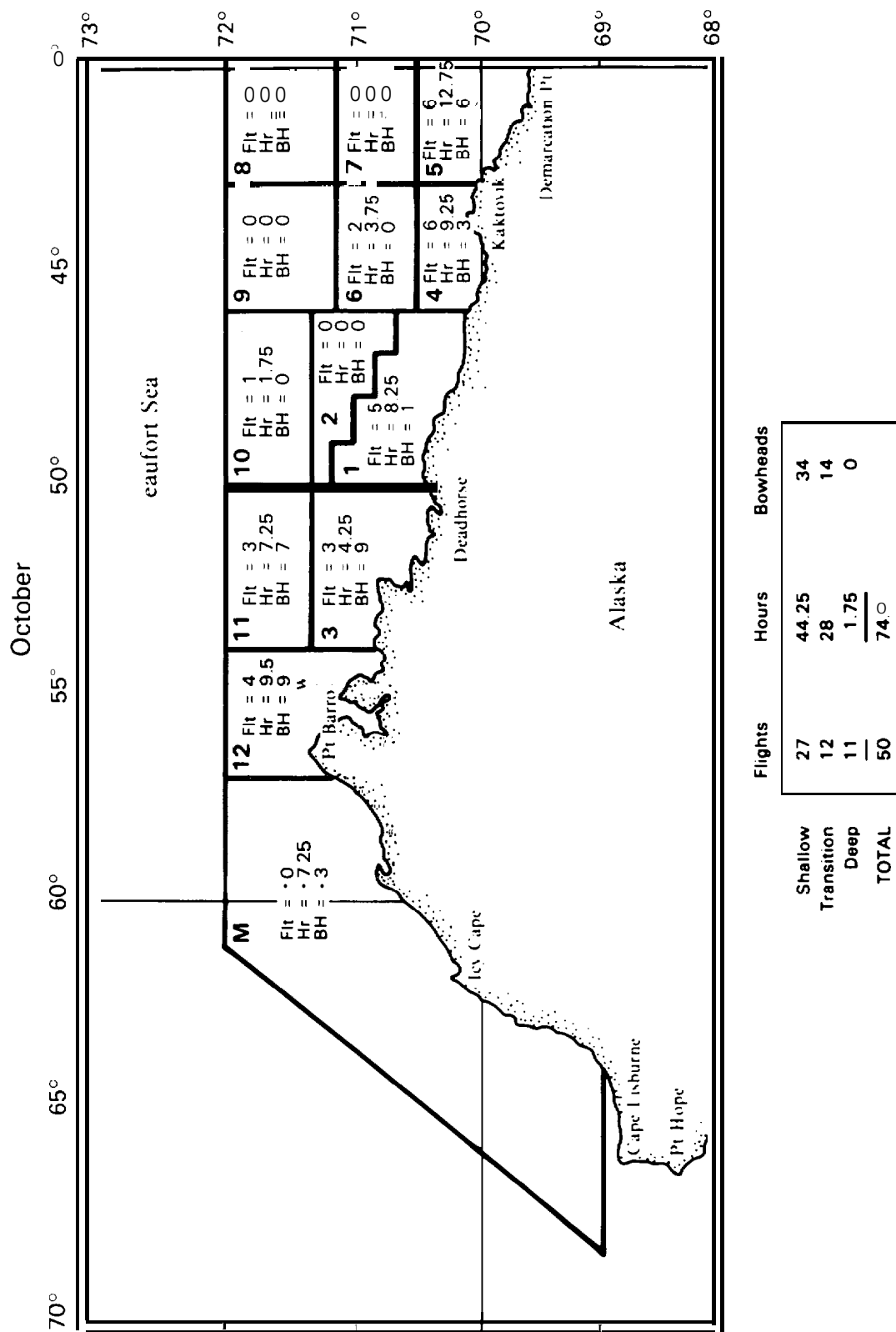


Figure 17. Flight effort and sighting summary by survey blocks # 1-12 in the Beaufort Sea and block M in the Chukchi Sea, October 1982.

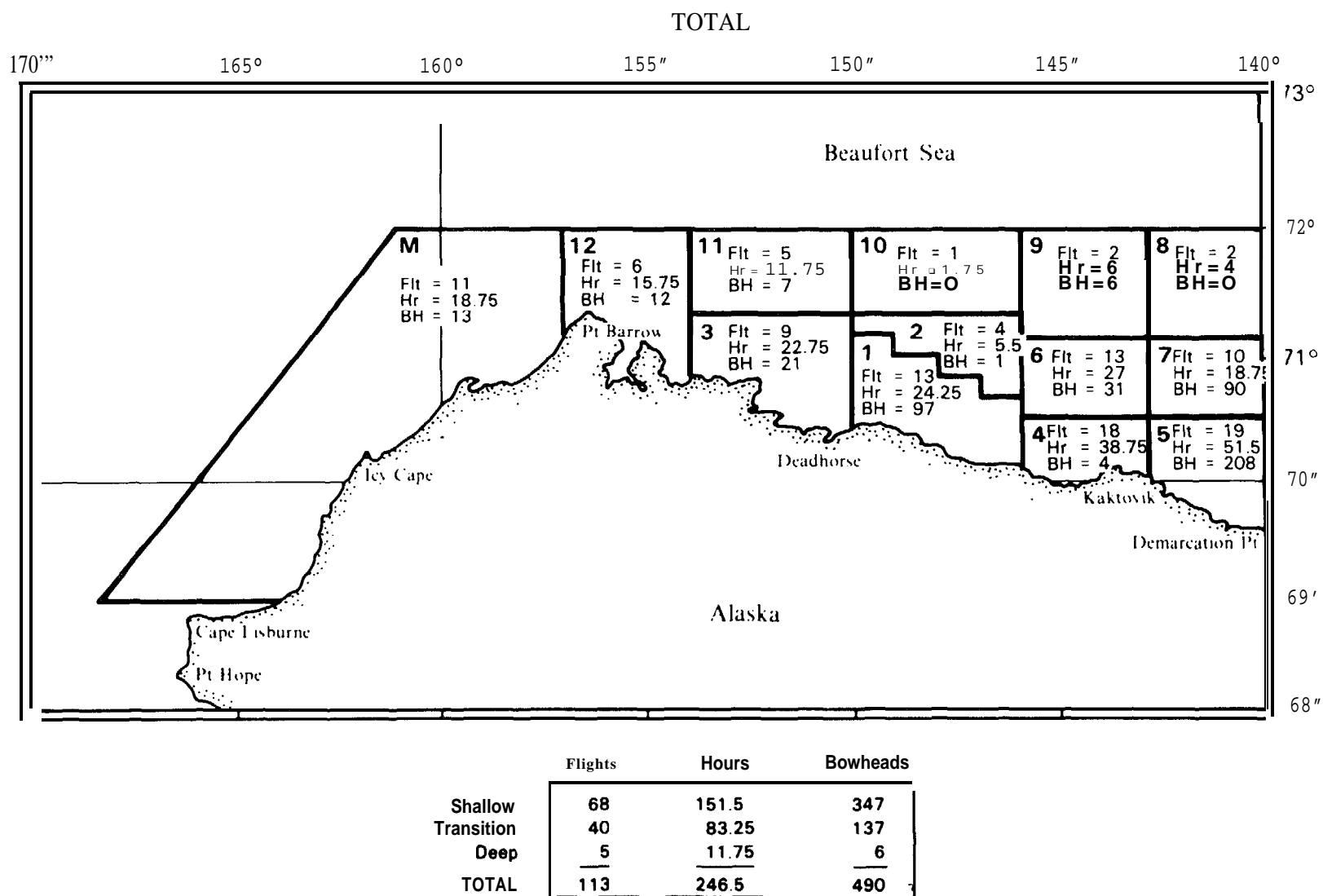


Figure 18. Flight effort and sighting summary by survey blocks#1-12 in the Beaufort Sea and block M in the Chukchi Sea, August-October 1982.

Demarcation Bay (Figure 16). Sightings in October were also predominantly nearshore, with the highest count in block 2 (Figure 17). Figure 18 shows 222 sightings of 490 bowheads. It represents the overall results from August through October 1982. Subregional density estimates, including a bimonthly presentation for the August-October period, is presented in Appendix B.

Migration Timing and Habitat Relationships

The first component of the fall bowhead migration was seen in early August in the deep and transitional depth zones of the eastern U.S. Beaufort Sea. A shift in sightings per unit effort from deep and transitional to shallow depth zones occurred in mid-September as more whales were found nearer to shore (Figure 19). The survey effort was concentrated in shallower areas during September, but deep-water areas were still surveyed.

The average estimated swimming speed and direction of whales seen in fall 1982 are presented in Figure 20. Whales seen in the transition and deep areas in early August were swimming about 2 km/h to the west. Estimated swim speed increased to 4 km/h or more during late August and September. In October, swimming speed was estimated at 2 km/h. Bowheads had **unimodal**, nonrandom headings in all **periods** except early September, when feeding activity predominated. Swimming speed was not estimated for bowheads that appeared to be feeding in September.

Bowhead sightings per unit effort (**SPUE**) are shown in Figure 21. There appeared to be a peak in the nearshore bowhead migration between 18 and 24 September. On 16 September (Flight 66) **61** bowheads were seen east of **141°W** longitude (42 whales had been seen in approximately the same area the day before). On 18 September only 2 bowheads were seen west of **141°W** to **144°W** longitude by other observers.* On 22 September over 100 bowheads were seen between **141°W** and **143°W** longitude, * and on 24 September (Flight 70) we saw 159 bowheads distributed roughly between **140°38'W** and **149°42'W** longitude. On 29 September (flight 74) only 5 bowheads were seen between **147°37'W** and

*Personal communication, R. Davis, LGL Limited, Toronto, Ontario, Canada

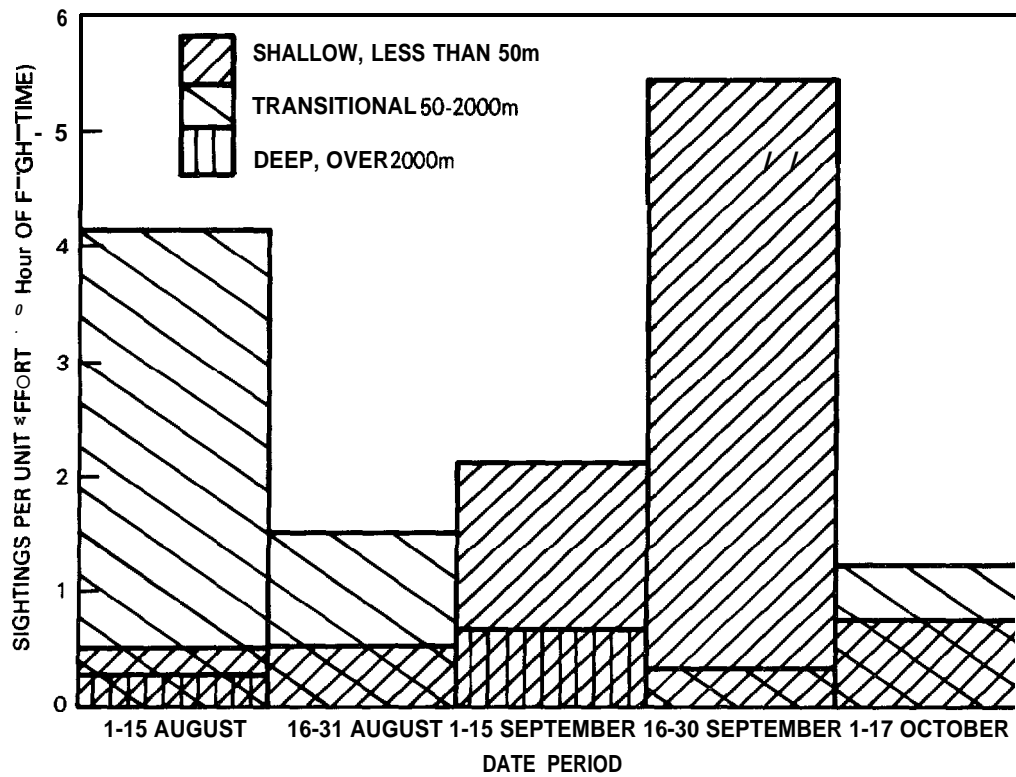


Figure 19. Bowhead deep (over 2000 m), transitional (50 m -2000 m) and shallow (less than 50 m) water sightings, fall 1982.

DIRECTIONALITY OF WHALES

----Expected = 12.5%
(Swim Speed (Est)-Mode)

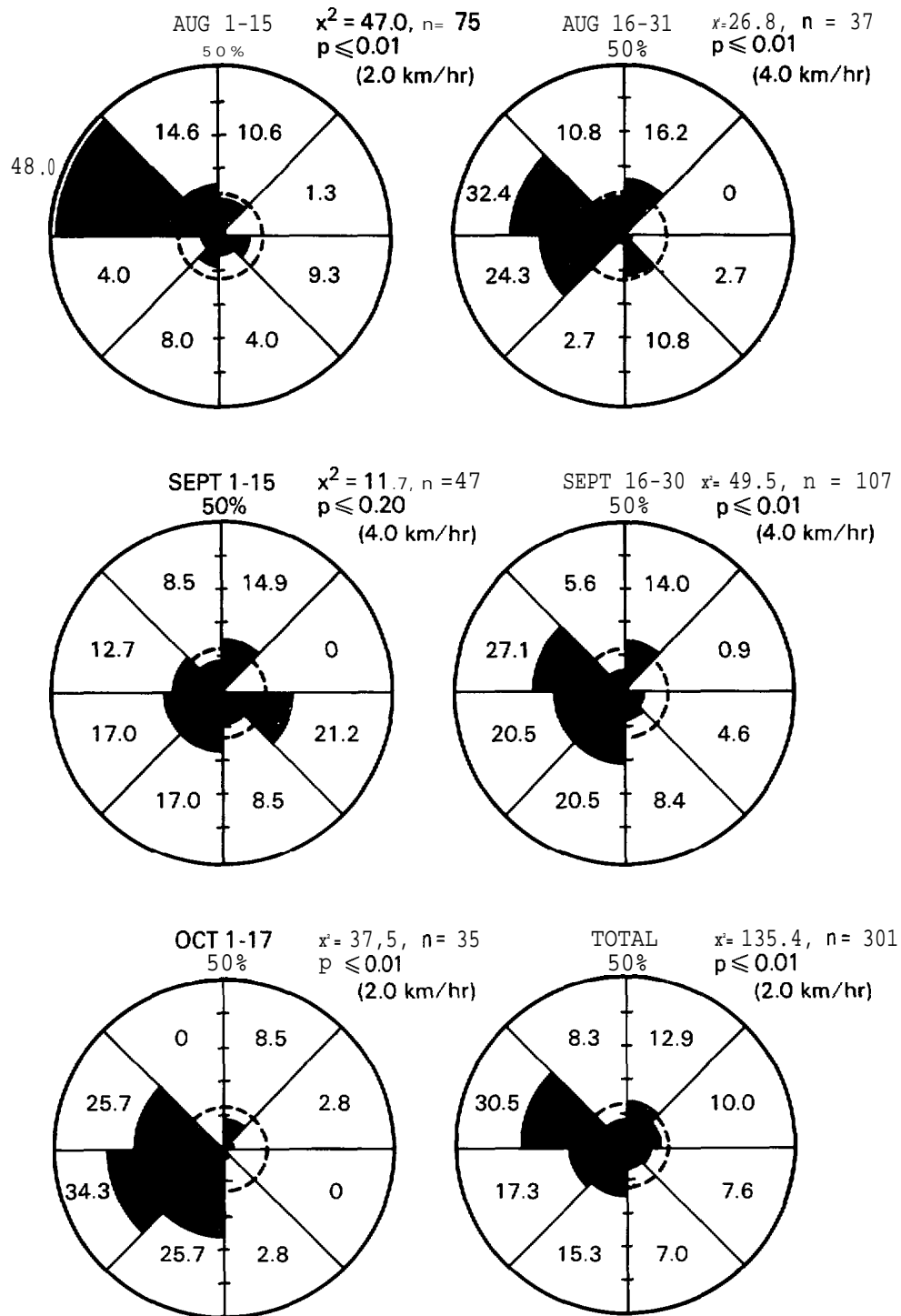


Figure 20. Mode estimated swimming speed and direction of bowhead whales, fall, 1982.

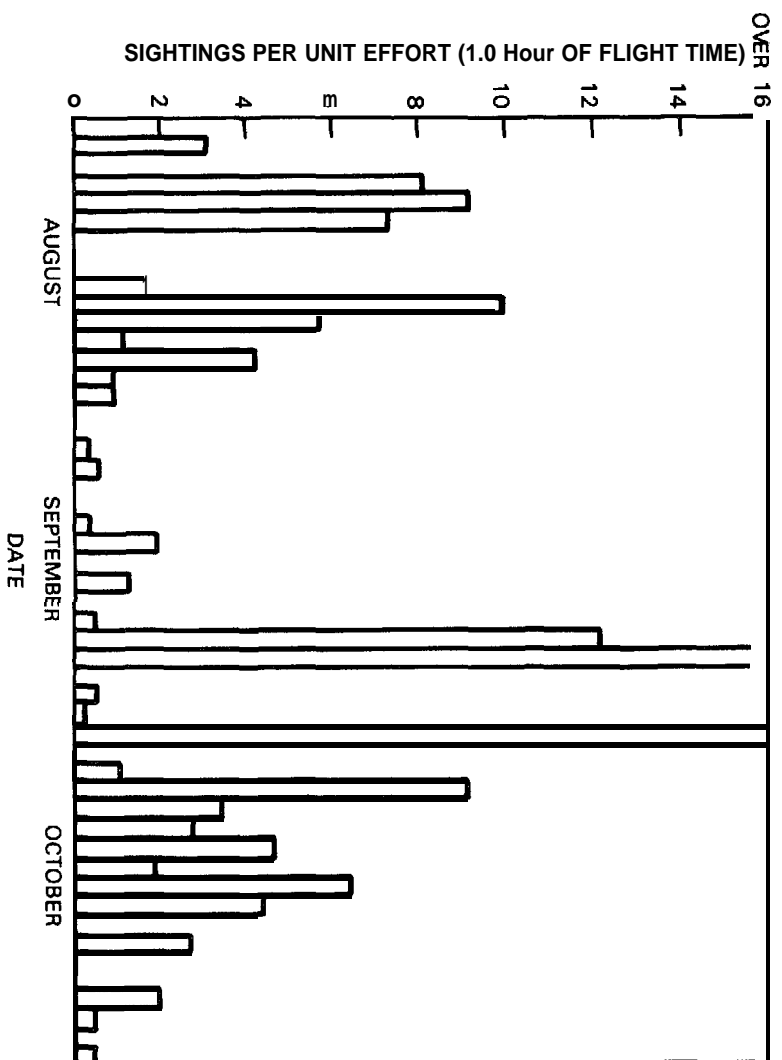


Figure 21. Bowhead sightings per unit effort, fall .982.

149 °43'W in an area where 44 whales were seen on 24 September. Thus, most whales were seen east of 141°W longitude before 18 September, were distributed progressively westward on 22 and 24 September, and were found in significantly smaller numbers along their westward distribution by 29 September.

The sighting distribution on 24 September (Flight 70) showed two possibly distinct groups of bowheads; one (n = 85) roughly between 149°42'W and 146°04'W longitude, and one (n = 73) between 142°47'W and 140°38'W longitude (with 1 bowhead seen at 70°18'N, 144°02.6'W). Most of these whales were swimming slowly and some appeared to be feeding. The 85 whales in the western group were in a nearshore area whose waters and productivity may be influenced by runoff from the Colville and Sagavanirktok Rivers. Similarly whales found to the east were in waters where runoff from the Kongakut and Mackenzie Rivers possibly influence productivity and thus whale distribution. Schell et al. (1982, p. 81) stated that "the retreat of the pack ice northward in summer, nutrients supplied by terrestrial runoff, and the maximum euphotic depths lead to the maximum productivities observed" in the Beaufort Sea. This same report indicates that average (1978-1980) annual primary production contours in the U.S. Beaufort grossly depict production of 25 to 27.5 gC/m² occurring from shore to about 71°N latitude at 141°W longitude, and 25 to 40 gC/m² from shore to 72°N latitude at 157°W longitude. These contours roughly encompass the area of fall migratory bowhead distribution in the Beaufort Sea seen this year and in past years (Ljungblad, 1981; Ljungblad et al., 1982).

Furthermore, this year's observations of early offshore and later onshore bowhead sightings roughly coincided with peaks in primary production in the Beaufort Sea that occurred in June offshore and in August nearshore reported by Schell et al. (1982). Such peaks in primary production are generally followed by peaks in numbers of primary and secondary consumers, which in turn become food for bowhead whales. Schell et al. (1982) also presented data that suggested nearshore bowhead feeding areas in the fall may exist near Barter Island and north of Smith Bay. Though we have observed bowheads that apparently were feeding near Barter Island, we have seen few bowheads near Smith Bay and none feeding there. Ray and Wartzok (1980) reported 107 bowheads near the Smith Bay area on 20 September 1974. Braham et al. (1980a) reported 102

bowheads, many of them feeding, seen east of Pt. Barrow to Smith Bay between 20 and 26 September 1976. The extent and timing of past surveys have not established the importance of the Smith Bay area as a bowhead feeding ground. In this and previous years our surveys of the Smith Bay region have either been early (July, 1980, > 8/10 ice coverage) or late (late September and October, 1981-1982, > 8/10 ice coverage) in the season when the shallow bay and adjacent waters were frozen. Whales seen offshore, northeast of Barter Island in early August, could arrive in the nearshore area west of Smith Bay by late August or early September. Surveys conducted somewhat after the predicted arrival of these bowheads may provide additional information about possible bowhead feeding areas from Smith Bay to Pt. Barrow.

It seems that the "offshore" and "nearshore" migrations were not two separate and distinct processes, but overlapped within the same migration. Multiple regression analysis describing depth (d), as a function of sighting date (t), and ice coverage (i) shows a somewhat smooth and strong fit ($d = 776.3 - 14.4t + 47.18i$; $R^2 = 0.431$; $F = 15.82$). The deeper offshore migration occurred in early to mid-August, then shifted to the shallower nearshore migration by mid-September. In September whales were found in 20- to 50-m water during which time they progressed slowly west apparently feeding along the way, as more whales moved into the U.S. Beaufort from the east. The histogram of sightings per unit effort by date shows two apparent peaks (see Figure 21); however, the poor weather in late August and early September must be considered. Flight conditions were unacceptable (fog, icing, and high sea states) as evidenced by the small proportion of days permitting flying. The weather on only 37% of the days between 26 August and 13 September was adequate for flying, compared with 73% for the overall fall season. Thus there was probably a continuous "flow" migration of bowheads through the Alaskan Beaufort Sea.

Fifteen whales were seen in the Chukchi Sea between 2 and 17 October. These whales were distributed between 156°58'W and 160°34'W longitude and 70°47'N to 71°45'N latitude (Figure 22). Additionally, bowhead whale tracks in the ice were seen along a search line between 70°30'N, 163°23'W and 71°24'N, 160°46'W indicating bowheads had recently moved through the area. Swimming direction of the whales ranged from 330° to 200°T, with significant

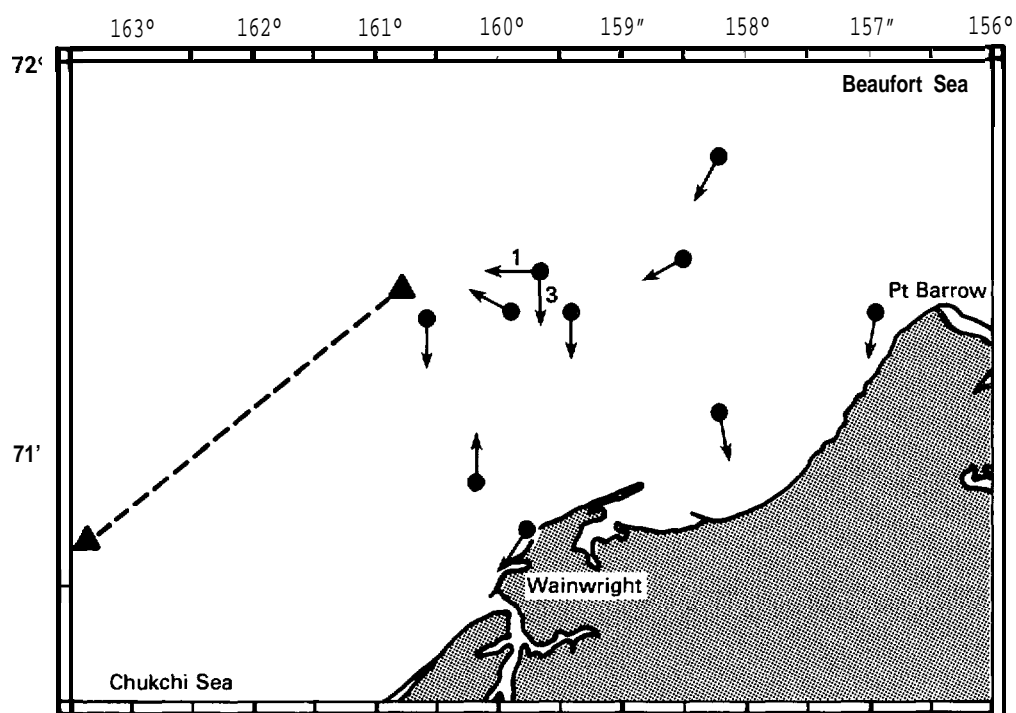


Figure 22. Distribution of 10 sightings representing 15 bowhead whales seen in the Chukchi Sea between 2 and 17 October 1982. Arrows indicate whale direction; dashed line indicates ice tracks.

clustering about a mean of 265° T (Laubscher and Rudolph test, $R = 130^\circ$, $p \leq .005$). One bowhead seen **nearshore** on 3 October breached six times at approximately 30-s intervals as it moved south very near the shoreline. On 9 October, five whales (36%) were seen resting at the **surface**. Four of these were within a body length of one another with one whale headed at 300°T while the other three lay **parallel** to each other maintaining a **210°T** direction. The fifth resting whale was approximately 11 km southeast of the group of four. None of the resting whales reacted to the aircraft as it flew over at 244 m. The last bowhead seen this year was an individual in the Chukchi Sea (at **71°19.7'N, 160°34.1'W**, on 17 October) swimming south at an estimated 4 km/h.

We believe the type of distribution observed in the Beaufort and **Chukchi** Seas during the fall **1982** migration can be depicted by a westerly moving, continuous distribution of bowheads in a general trapezoid shape moving west across the **Beaufort** Sea and dispersing southwest across the **Chukchi** Sea (Figure 23).

The following observations support this hypothesis:

- In August bowheads were seen further offshore to the west and closer to shore as we surveyed east,
- the direction of the bowheads remained significantly westerly (see Figure 28) from August through October (except for whales believed to be feeding), and
- mode-estimated swimming speeds **were 2 km/h** in early August and 4 km/h for migrating whales observed in September. These speeds put whales in approximate locations suggested by this migratory model, and in areas where they were seen during the migration.
- bowheads seen in the **Chukchi** Sea in October exhibited a significant mean heading of 265°T.

In this **model**, the bowheads seen offshore in early August are the leading edge of a much larger westerly moving population and suggest that major migratory movements could occur that early in the Alaskan Beaufort Sea. By the first part of September, whales were seen near Demarcation Bay and Barter Island. The continued westward movement brought a great population of the

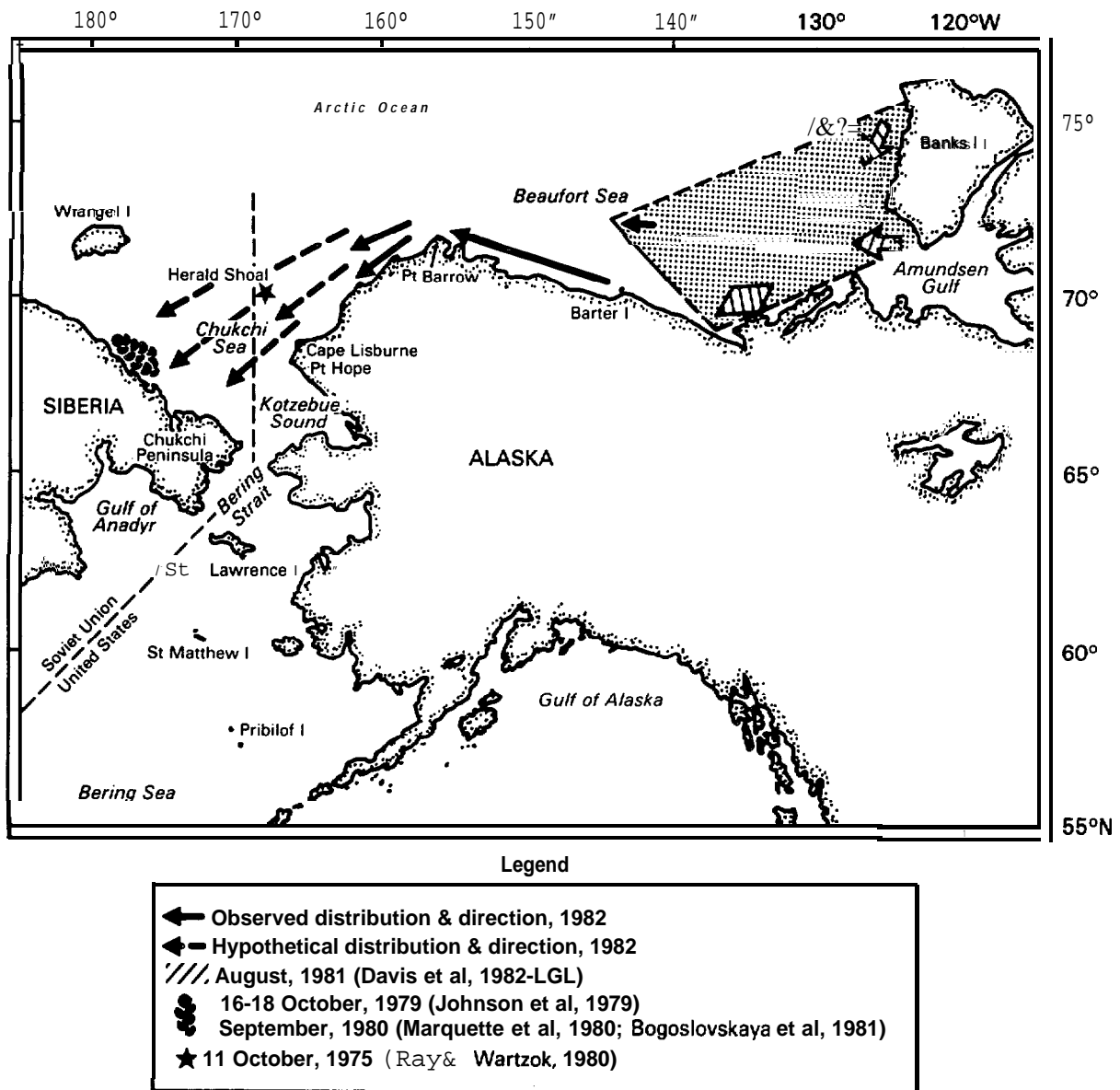


Figure 23. General representation of likely fall bowhead migration showing approximate distribution in August, September, and October 1982.

population through the Beaufort Sea, progressively nearer shore, in September and October.

This model addresses observations made by other researchers in 1982 of bowheads encountered approximately 100 km NE of Barter Island in August (Davis et al., 1983), and our observations in 1982 and Previous Years of **bowheads** seen feeding near Demarcation Bay in early to late September, then swimming west through the nearshore Beaufort Sea in late September and October (Ljungblad, 1981; Ljungblad et al., 1982).

Our fall bowhead sightings in the **Chukchi** Sea can be encompassed by a rectangle bounded by latitudes **71°45'N** and **70°47'N** and longitudes **156°58'W** to **160°34'W** (see Figure 22). If an average westerly heading of 265° T is applied to that rectangle, a hypothetical picture of bowheads dispersing across the **Chukchi** Sea and crossing roughly over Herald Shoal (**70°30'N, 171°30'W**) develops. This pattern of a possible southwestward dispersion of many bowhead whales across **the Chukchi** Sea in fall complements, yet diverges from the currently held model (Braham, et al., 1980b), suggesting that bowheads primarily follow the ice front west to Herald and **Wrangel** Islands before following the Chukotka peninsula south and through the Bering Strait. Ray and Wartzok (1980) reported five **bowheads** slightly west of **Herald Shoal** on 11 October 1975. Johnson et al. (1981) reported 104 bowheads sighted along the Siberian coast between Tenkergin and Cape Onman (**68°N-69°N, 174W-178°W**) between 16 and 18 October 1979, whereas only three bowheads were observed northeast of **Wrangel** Island. **Bogoslovskaya** et al. (1981) reported 274 bowheads along the mainland coastline between early September and mid-October, with only 4 to 12 whales seen off Herald Island in October 1980. Marquette et al. (1981) reported 227 bowheads sighted along this strip of the Siberian coast between 21 and 23 September 1980, with no bowheads seen near **Wrangel** or Herald Island. Our data, in conjunction with these published accounts, supports the hypothesis of a dispersion of bowheads south and west across the **Chukchi** Sea after they round Pt. Barrow late in the fall (see Figure 23). Migration patterns in the **Chukchi** Sea may be more dispersed, compared with **the** Beaufort Sea perhaps, due to differences in the bathymetry and ice.

It **is** possible that bowheads encountered along the Siberian Coast in early autumn were whales that did not migrate as far east as the eastern Canadian Beaufort Sea in spring. **Bogoslovskaya** et al. (1981) reported 20 bowheads sighted about 30 km northeast of Cape Serdtsekamen in August of 1973, and 13 whales seen near Cape Billings in late August of 1977 and 1978. Ray and Wartzok (1980) reported 64 bowheads seen about 100 km north of **Icy Cape** in August of 1975. Braham (1982) cited several other reports representing approximately 20 bowheads in the northern Bering and **Chukchi** Seas between June and August. Thus, while it is not certain that whales seen by others along the Siberian coast in September and October did, in fact, migrate from the Beaufort Sea, the dramatic increase in the number of bowheads reported along the coast in September and October supports the contention that whales were newly arrived in the area at that time.

Possibly the bowheads we saw offshore in early August were whales that did not make the complete migration to the Banks Island - **Admunsen** Gulf area. To swim to Banks Island and back from the position of our first August sightings would be a round trip of approximately 1000 km. Swimming at an average speed of 2 km/h from early June until early August a whale could cover the distance easily, but it would have little time for feeding or resting before the return migration. More likely, perhaps, is that some of the whales seen migrating past Pt. Barrow in late May and early June were whales that did not move much further east but instead exploited an offshore food source that began to falter soon after the peak bloom in July (**Schell** et al., 1982). These whales then returned west at the beginning of the fall migratory cycle. In short, late arrivals to the Beaufort Sea may be the early westerly migrants. 'Ibis shortening of the migratory route has been observed in gray whales (**Braham**, 1983). Late southbound grays have been seen turning near San Francisco, California, and returning north with whales swimming north from the breeding lagoons. These "late" gray whales, in effect, short circuit the migratory route to the breeding lagoons by simply ending it halfway down the California coast. **In** a similar fashion we suggest bowhead whales that round Pt. Barrow in the latter part of the spring migration (June) may remain well offshore and swim no farther east than approximately Demarcation Point. When offshore food sources are reduced in availability in August, they may be the

first whales to move west and initiate the fall westerly migration instead of moving south into shallower waters.

Rates and Sizes of Bowhead Calf Sightings

All calf sightings (n = 42) are plotted in Figure 24. Estimates of gross annual recruitment rate (**GARR**) for bowhead whales have usually been low **relative to other mysticetes. A range from low estimates of 1.3% (Braham et al., 1979), 1.9% (Davis et al., 1982) and 2.3% (Dronenburg et al., 1982), to highs of 3.4% (Cubbage and Rugh, 1981), 5.6% (Marquette et al., 1981) and 9.3-12.4% (Davis et al., 1983) have been reported.** The number of calves sighted by this project in the fall (Table XIII) and resulting GARR were higher than our other seasons (Table XIV) or other aerial survey estimates. Twenty-three calves, or 4.69% of the total number of whales sighted (n = 490) were encountered while on transect survey in the fall. This amounted to 0.000190 calves per adult per hour of flight time. Nineteen calves, or 8.19% of the total number of bowheads sighted (n = 234), were seen **while** collecting behavioral data in the fall (Reeves et al., 1983), or the equivalent of 0.001242 calves per adult **per** hour of flight time. Behavioral observation flights had greater chance to sight any calves present because of time on station, but did not representatively nor randomly sample the whole population and/or region. Thus the best estimate may be between the two. A GARR of 5.80% or equivalent of 0.000186 calves per adult per hour of flight time may be calculated from the combined sightings of 42 calves/724 total whales. Bowhead calf sighting rate and derived GARR are compared to other years and seasons in Table XIV.

There did not appear to be any significant segregation according to size in the **fall** migration. The whales seen offshore in August, when the large proportion of calves were noted, were the same average size index ($\bar{x} = 0.688 \pm 0.180$, **s.d.**) as the early (4-22 September) nearshore component ($\bar{x} = 0.662 \pm 0.151$, **s.d.**) and the late (23 September-17 October) nearshore component ($\bar{x} = 0.677 \pm 0.234$, **s.d.**; $t=0.66$, $p \leq .50$, $n=106$).

Date	Flight No.	Latitude°N	Longitude°W	No.	N642 sight- ing	Heading ("M)/Comment
<u>Fall</u>						
		70°32'	40°31'	1		under adult, 360°M
15 Aug	43	70°55'	43°09'	1		adult cluster around calf
		70°53'	43°01'	1		210°
		70°26'	42°39'	1		090°
16 Aug	44	70°54'	42°43'	1		270°
17 Aug	37	71°03'	44°07'	1		all black
18 Aug	46	70°14'	39°45'	1		150°
		70°23'	40°12'	1		3600
		70°15'	40°43'	2		240°
20 Aug	47	70°36'	41°43'	1		mottled tan, 260°, no cow seen
8 Sep	61	71°26'	45°33'	1		270°, 2 km/hr
14 Sep	11	70°12'	44°40'	1	*	gray, small
		70°11'	44°36'	1	*	associated with group of 10-12 adults
15 Sep	64	69°56'	40°40'	1		nursing
		69°50'	140°09'	1		
		69°57'	139°56'	1		210°
	13	70°30'	146°38'	1	*	associated with group of 5 adults
		70°19'	145°47'	1	*	cow/calf
	14	70°41'	146°34'	2	*	associated with group of 8 adults
16 Sep	66	70°00'	140°15'	1		black
		69°56'	140°08'	1		
		69°56'	140°00'	1		
		69°58'	140°47'	1		270°
17 Sep	16	70°31'	145°57'	2	*	cow/calves
23 Sep	21	70°34'	146°49'	1	*	large; solitary
		70°23'	144°13'	1	*	gray, small, with adult, 240°
	22	70°49'	148°42'	2	*	associated with group of 5
		70°51'	48°39'	1	*	1/3 length of cow
24 Sep	70	70°52'	49°42'	2		210°
		70°45'	46°48'	1	*	attempted or interrupted nursing
	24	71°03'	48°43'	1		6 m, solitary
		71°02'	48°40'	1	*	cow/calf
25 Sep	25	70°49'	149°19'	1	*	cow/calf all associated
		70°50'	149°20'	1	*	cow/calf together
		70°50'	149°21'	1	*	solitary
28 Sep	28	70°16'	144°41'	1	*	cow/calf
4 Ott	78	70°50'	150°35'	1		all black 10m from adult

Total = 42 (N642 = 19)

Table XIII. Bowhead calf sightings, fall 1982.

Season	No. calves	No. whales	GARR	No. hours flown	No. calves
					No. whales
					No. hours
Fall ' 79	6	249	2.41	277.0	0.000087
Spring 80	4	857	0.47	116.5	0.000040
Fall 80	1	49	2.04	234.5	0.000087
Spring 81	0	1222	0.00	164.0	0.000000
Fall 81	3	171	1.75	134.2	0.000131
Spring 82	2	265	0.75	93.4	0.000081
Fall 82 (N780)	23	490	4.69	246.5	0.000190
Fall 82 (N642)	19	234	8.12	65.4	0.001242
Fall 82 (N642+ N780)	42	724	5.80	311.9	0.000186

Table XIV. Bowhead calf sighting rate and derived GARR
(no. calves/no. whales), 1979-1982.

In August, calves were seen close to cows (within a body length) and were usually accompanied by other whales. The largest accompanying group was 12 adults to two cow-calf pairs. In September, the cows and calves were seen further apart (up to 2 body lengths) and infrequently quite far apart (up to 15 body lengths) when the cow dove, presumably to feed. One calf was seen without sighting a cow but the calf was not resighted to confirm if it was alone.

Attempts at nursing were noted as late as 24 September and no calves were observed filter-feeding. Durham (1980) cited evidence of mature baleen in calves 6 months of age. The close association of calves (and maybe yearlings) to cows may be related to factors other than nursing. There may be a need to closely associate with adults to learn about the environment (Brodie, 1969). It is hypothesized that even if weaned at 5 months and about 6 m length (Nerini et al. 1982), the calf may stay with the cow at least until the end of the fall migration in the Bering Sea and possibly as a yearling into the next spring migration.

Time series comparisons of the ratios of calf lengths to their cows' lengths reveal relative growth rates. In the spring the photographed calf

averaged 36% of its cow's length. Researchers in the Canadian Beaufort in August found **that** calves were 41% of their cows' lengths (n = 42, Davis et al., 1983). In the Alaskan Beaufort in August and September the calves were 47% of their **cows'** length (n = 9, **s.d.**'= 0.06). **LGL** also reported that summer yearlings were 56% of their probable cows' length (n = 13, Davis et al., 1983).

Behavior, Feeding, and Sound Production

Bowheads occurred as singles or in groups of from 2 to 16 (\bar{x} = 2.21) between August and October. The predominant overall behavior of bowhead whales in the Alaskan Beaufort and northern **Chukchi** Seas in the fall was active migration (swimming and diving = 54%, n = 263, Table xv). Other behaviors were noted in high proportions during different phases of the season. For example, 32% (n = 12) of the whales sighted in late August were milling and 20% (n = 49) sighted in late September appeared to be feeding. From 14 to 24 September, increased suspected feeding behavior occurred between Herschel Island and **Flaxman** Island. There had been a seasonal bloom of primary producers, and theoretically, an increase in the small invertebrate **food** of bowheads. This happened coincident with the retreat of the ice, the start of significant river runoff and the euphotic depth increase (**Schell** et al. 1982). The water column, where whales appeared to be feeding, was murky green, and whales were observed filtering the water such that clearer water trails appeared behind them as they swam. These water-column feeding whales usually were observed in organized groups which dove for relatively long periods of time and often surfaced synchronously or nearly so. The feeding whales swam in elongated but closed chevron formation and **in** follow-the-leader formations similar to patterns described by **Würsig** et al. (1982). They were noted predominantly in 20-m to 30-m water that may be influenced by runoff from the Mackenzie, Sagavanirktok and **Colville** Rivers.

As in the spring, **some** whales during September surfaced with their heads and portions of their bodies covered with mud (Figure 25). However, no mud plumes nor mud tracks as described by **Würsig** et al. (1982) were noted. Benthic (**epifaunal**) organisms as well as pebbles and a clam have been retrieved from stomach contents of a bowhead whale taken at Barter Island

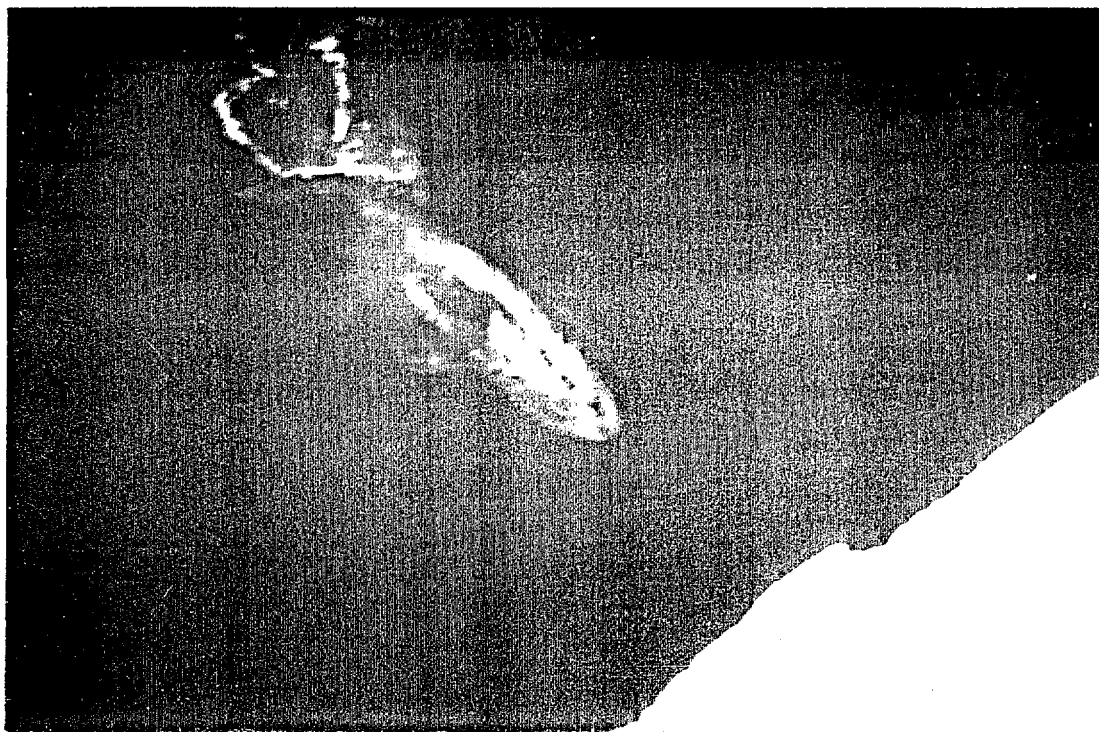


Figure 25. Mud-covered bowhead whale.

<u>FALL</u>	Aug 1-16	Aug 16-31	Sep 1-15	Sep 16-30	Ott 1-17	Total
BEHAVIOR:	#/%	#/%	#/%	#/%	#/%	#/%
SWIM	67/62.0	6/16.2	21/38.9	95/38.5	29/65.9	218/44.5
DIVE	5/4.6	5/13.5	11/20.3	24/9.7	3/6.8	48/9.8
STILL	20/18.5	7/18.9	1/1.9	13/5.2	9/20.4	50/10.2
MILL	12/11.1	12/32.4	7/12.9	50/20.2	0/0	81/16.5
CALF	4/3.7	5/13.5	7/12.9	0/0	2/4.5	18/3.6
DISPLAY	0/0	2/5.4	7/12.9	12/4.8	1/2.3	22/4.5
FEED	0/0	0/0	0/0	49/19.8	0/0	49/10.0
NONE	0/0	0/0	0/0	4/1.6	0/0	4/1.0
TOTAL	108/100	37/100	54/100	247/100	44/100	490/100
AVERAGE GROUP SIZE	1.89	1.68	2.16	2.77	1.52	2.21

RESPONSE
TO AIRCRAFT

YES	105/97.3	36/97.3	46/85.2	31/12.5	21/47.7	239/48.8
NO	3/2.7	1/2.7	8/14.8	216/87.5	23/52.3	251/51.2
TOTAL	108/100	37/100	54/100	247/100	44/100	490/100

Table XV. Summary of bowhead behavior, group size and apparent responses to aircraft, fall 1982.

(Lowry and J. Burns, 1980). * Finally, a few bowheads were seen apparently surface skimming with open mouths in clear water on 24 September near Demarcation Bay. These whales were not oriented in any particular direction nor moving west.

Suspected bowhead feeding areas representing 15 dates and 22 locations over 4 years (1979-82) in the Alaskan Beaufort Sea during the fall migration are outlined in Table XVI and depicted in Figure 26. Although many additional observations of possible feeding behaviors were made over those years, these selected data represent groups of whales that remained in the same general area for extended periods and exhibited at least three of the following conditions:

echelon swimming formations

mud or silt streaming from the mouth (head)

clear swaths of water appearing behind whales swimming through murky waters

non-directionality

defecation

synchronous group diving and surfacing

millling; slow overall movements

open mouth surface swimming

Unusual behaviors observed in the fall included: the sighting on 7 August of a clustering of eight bowheads in an apparent response to the aircraft during a low sonobuoy drop (Figure 27a), and on 16 August four adults gathered near a calf that was nursing (Figure 27b); protracted (10 rein) mutual slapping with the tail by two whales on 18 August (Figure 28); active swimming in a tight circles by groups of up to eight whales on 18 August; sexual play and apparent social displays. On 24 September a medium-sized whale spy-hopped

*personal communication, L. Lowry, 1983, Alaska Department of Fish and Game, Fairbanks, AK.

Date	Group size	Latitude, °N	Longitude, °W	Directionality ¹⁾	Observed behavior	Surface Times *	Dive Times *	Comments
24 Sep 1979	3,5,5,5 10,4,11	69-55	141-50	Bimodal east/west $\chi^2=12.75$ n=10 p<.10	Feeding			No response to aircraft, 100-min observation
26 Sep 1979	9,4,3,3,6 2,5	69-45	141-02	n=5	suspected Feeding			filling, slow swimming
14 Sep 1980	3	70-06	142-48	n=6	Feeding			Mud trails in water
12 Sep 1981	3,5,7-8	69-49	740-55	Random $\chi^2=4.32$ n=12	Feeding	3:28 3:30 2:18 1:39 3:34 5:31	10:17 5:18 5:23 4:58	Near ice seismic sounds present
17 Sep 1981	4	70-01	140-50	n=9	Social		8:14 10:35 11:14	

Table XVI. Suspected bowhead feeding areas, 1979-1982.

1) if n ≤ 9, no statistical test performed

* - from observer's note book

Date	Group size	Latitude, °N	Longitude, °W	directionality ¹⁾	Observed behavior	Surface Times*	Dive Times*	Comments
20 Sep 1981	3,4, upto 9	70-06	141-55	Westerly $\chi^2 = 13.32$ $n=24$ $p < .10$	Social Feeding	2:12 2:16 3:30 2:37 2:43 2:54 2:20	7:38 7:54 14:57 13:32 15:47 18:16 10:35	No response to aircraft No seismic sounds
22 Sep 1981	1's	70-02	142-29	Bimodal East and west $\chi^2 = 13.95$ $n=10$ $p < .10$	Feeding	1:19 2:39 2:27 1:47 2:42 1:21 2:01	10:28 10:40 14:00 9:19 11:37 8:40 10:18	Seismic sounds present, near ice pan
28 Sep 1981	3,6-8,1's	70-21	145-28	Westerly $\chi^2 = 16.38$ $n=44$ $p < .025$	Feeding	2:28 1:43 1:54 1:35 1:05	29:56 11:38 15:00 13:36 10:59 26:09	speed = 1 km/hr
2 Oct 1981	2,4,7,3, 5,3	70-23	145-32		Resting Swimming	1:52 2:31 2:54 2:57 2:52 2:29	14:00 9:57 11:54 13:11 13:15	60 min observation

Table xvi (cont). Suspected bowhead feeding areas, 1979-1982.

1) if $n \leq 9$, no statistical test performed

* - from observer's note book

Date	Group size	Latitude, °N	Longitude, °W	Directionality ¹⁾	Observed behavior	Surface Times*	Dive Times*	Comments
5 Oct 1981	1's	70-20	144-52	Northwesterly $X^2 = 12.0$ $n=12$ $p < .20$	Resting Suspected Feeding	2:20 2:31 1:32 1:18	13:43 6:29 4:14	Repeated surfacing in same area, non-migratory, no response to aircraft
14 Sep 1982	2-3, 6-7 12-14	70-11	144-37	n=0	Milling Suspected Feeding	1:07 0:44 0:49 0:46 0:30 1:03		Synchronous surfing and diving, touching
16 Sep 1982	5,12	70-00 69-50	140-15 140-00	Random $X^2 = 6.0$ $n=10$ $p < .50$	Feeding Milling			Closed chevron formation synchronous diving
23 Sep 1982	10-12	70-35	146-45	n=9	Feeding Milling	2:16 2:42 2:23 2:14 0:56 1:32 2:05 1:35 5:07 1:48 0:49 1:05	12:10 4:00 8:27 10:51 3:08 8:43 12:40 4:42 15:34 11:10 6:05 12:35	Synchronous diving no response to aircraft

Table XVI (cont). Suspected bowhead feeding areas, 1979-1982.

1) if $n \leq 9$, no statistical test performed
 * _ from observers **note book**

Date	Group size	Latitude, °N	Longitude, °W	Directionality ¹⁾	Observed behavior	Surface Times*	Dive Times*	Comments
24 Sep 1982	5,4,10,3 5,8,10	70-57 70-11 70-04 69-47 69-48	149-41 142-15 141-29 140-46 141-13	n=8	Feeding			Mud-covered whales, chevron formation, murky water with plankton plumes, cleared trails behind whales, skim and column feeding, swimming and turning
28 Sep 1982	5,3-6,3 9-12	70-41 70-50 70-47	148-58 149-57 149-45	Westerly $\chi^2 = 37.04$ n=19 p<.001	Feeding			Stationary feeding just below surface

Table XVI (cont). Suspected bowhead feeding areas, 1979-1982.

¹⁾ if $n \leq 9$, no statistical test performed
 * - from observer's note book

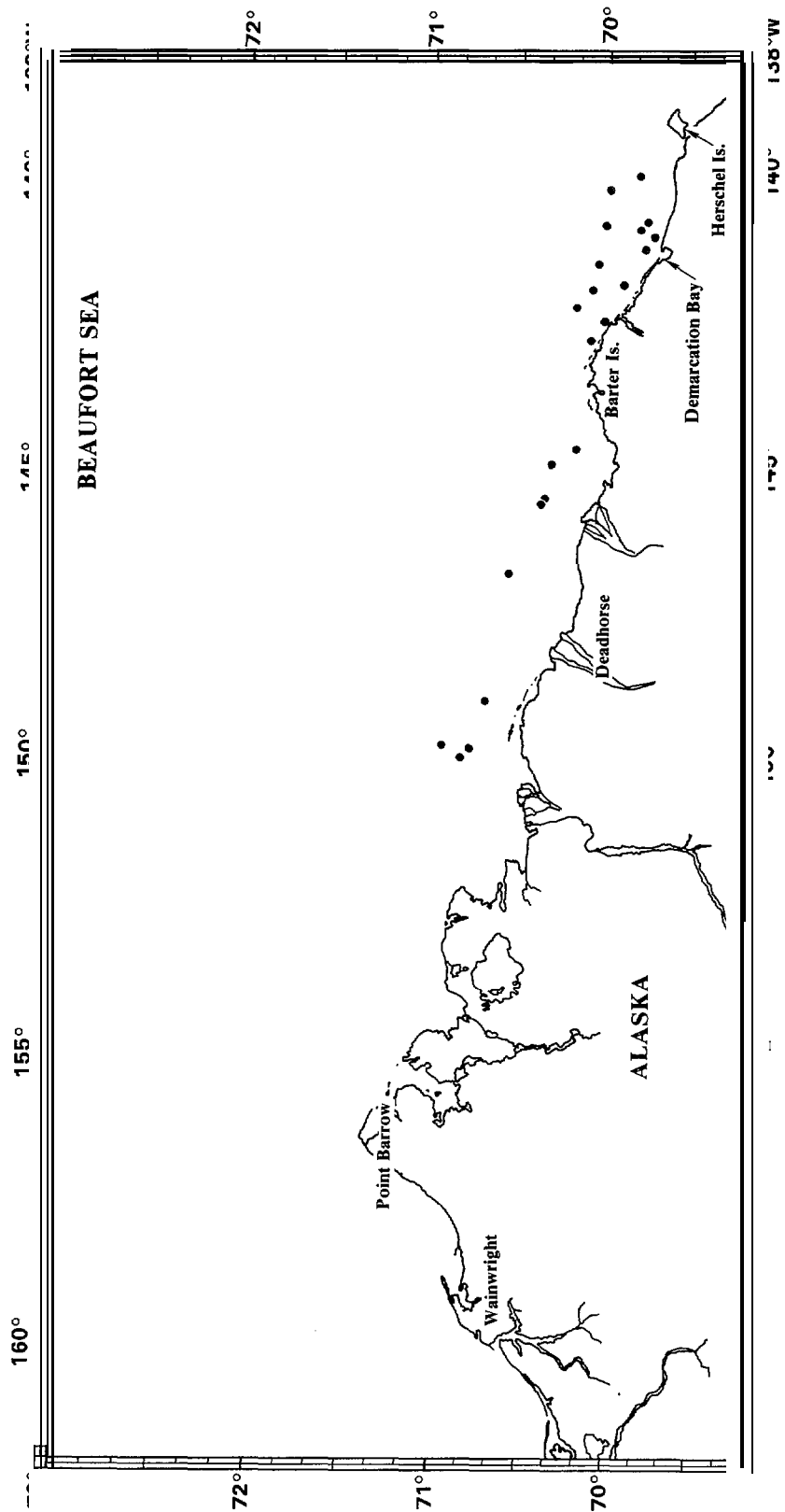
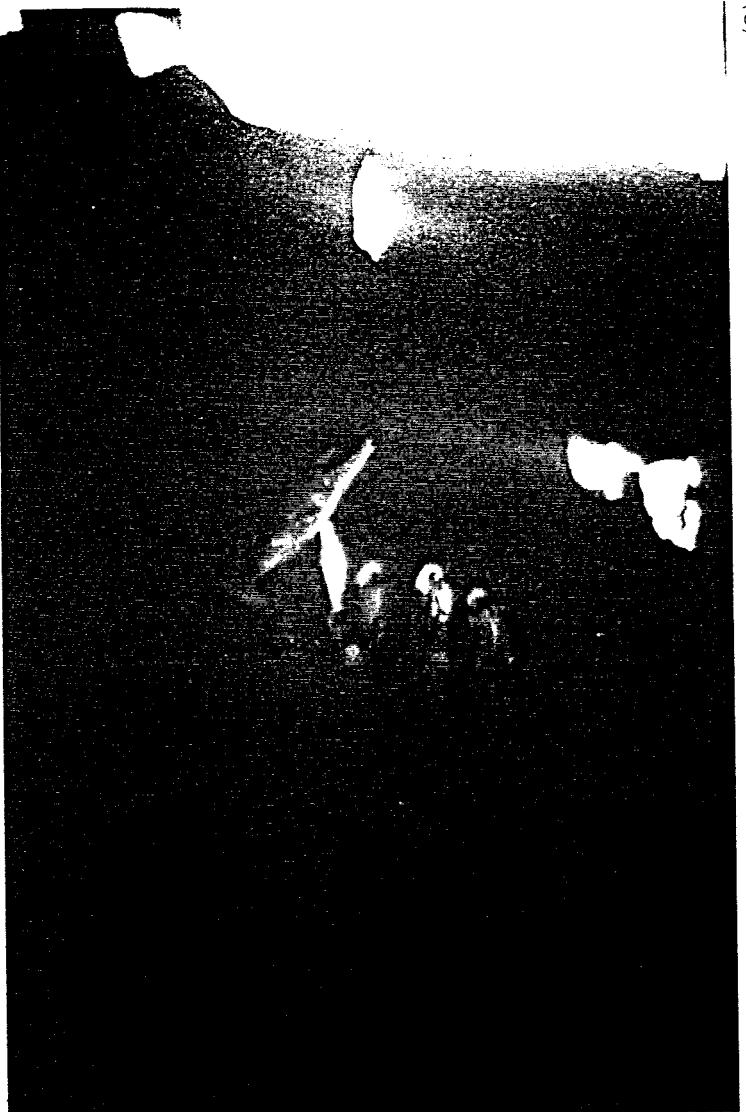


Figure 26. Suspected bowhead feeding areas, 1979–1982.



(a)



(b)

Figure 27 Clustering of bowheads in apparent response to a low sonobuoy drop (a); and near a calf (b).

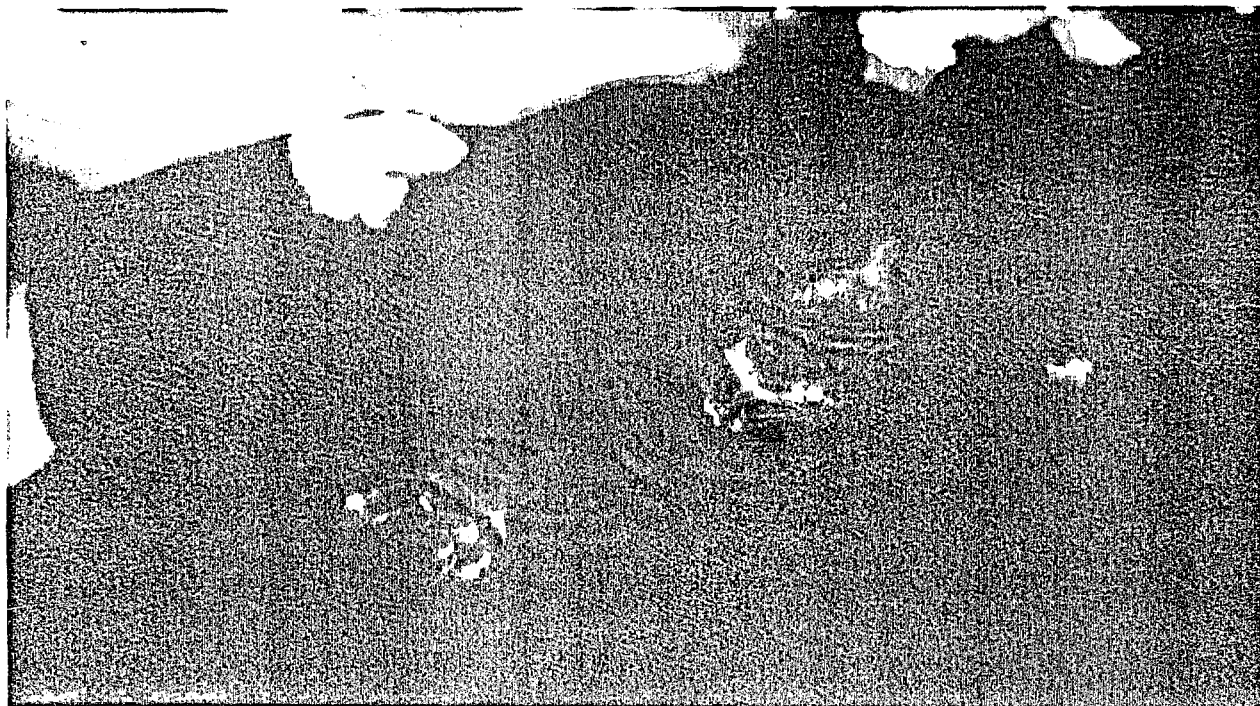


Figure 28, Bowhead tail slapping, August 1982.

once , then breached three times at approximately 50-s intervals. This was followed by quick tail slaps and then slower pectoral flipper slapping. This whale then was joined and touched by a recently surfaced whale. These two whales dove together after 5 s and were not re-sighted.

Sonobuoys were deployed and sounds recorded from bowheads that appeared to be migrating as well as social groups and single whales in the Beaufort Sea between 2 August and 25 September. Sonobuoys were dropped 23 times in the Beaufort Sea and twice in the Chukchi Sea (Table XVII). Results from initial aural analyses of bowhead sounds recorded in 1982 are presented in (Table XVIII).

Sounds were aurally analyzed as in the spring and placed into simple or complex moan categories subdivided according to frequency shift within the sound (See page 31). Unlike spring, most sounds recorded during fall were simple moans of either rising (up) or falling (down) frequency. Notably, the predominant behavior in the social groups recorded in the fall was feeding rather than mating, as was the case in spring.

Flight no.	Date	Area	Sounds recorded	Comments
34	8/2	W. Beaufort Sea	BH	
37	8/7	W. Beaufort Sea	BH	Few bowhead sounds.
38	8/8	W. Beaufort Sea	BH	Huddling.
40	8/12	W. Beaufort Sea		
41	8/14	W. Beaufort Sea	BH	2 calves; huddling; Few bowhead sounds.
44	8/16	W. Beaufort Sea	BH	Distant gee. boat.
45	8/17	W. Beaufort Sea		
46	8/18	W. Beaufort Sea	BH	
49	8/21	Beaufort Sea	no sounds	
53	8/24	Beaufort Sea	no sounds	
57	9/1	Beaufort Sea		No BH sounds.
58	9/2	Beaufort Sea		Distant gee. boat.
59	9/4	Beaufort Sea		Gee. boat.
62	9/11	Beaufort Sea	no sounds	
63	9/14	Beaufort Sea	BH	
64	9/15	Beaufort Sea	BH, BS	Cow-calf nursing.
66	9/16	Beaufort Sea	BH	
68	9/21	Beaufort Sea	no sounds	
69	9/23	Beaufort Sea	seismic sounds	
70	9/24	Beaufort Sea	BH	
71	9/25	Beaufort Sea	BH	Few bowhead sounds.
72	9/27	Beaufort Sea		No bowhead sounds. Distant gee. boat.
73	9/28	W. Beaufort Sea	coast guard vessel Polar Sea	
81	10/9	N. Chukchi Sea	no bowhead sounds	
83	10/11	N. Chukchi Sea	no bowhead sounds	Many bowheads. Ice tracks.

Table XVII. Sonobuoy drop locations and subject species, fall 1982.
(BH = bowhead whale; BE = belukha; BS = bearded seal.)

Of an overall (spring and fall) sound sample containing nearly 3000 discrete calls, 65.5% were simple moans, 24.2% were complex moans, and 10.3% were trumpeting calls. The biological significance of these sounds is difficult to interpret. Efforts to correlate sound production with behavior are confounded by observers being (1) uncertain as to which whales in a group were producing sounds, (2) unable to routinely categorize behavior of whales at the

Date	Sample duration	No. bow-heads	Call Rate	General Behavior	CALL TYPE #(%)							noise	comment	N
					Simple					Complex				
					up	down	constant	inflect	high	growl	trumpet			
8/2	16"	4	0.41	resting mild social	6(23)	3(12)		2(8)	5(19)	5(19)	5(19)	aircraft		26
8/7	28"	11	0.03	milling	5(50)	3(30)	2(20)							10
8/8	40"	8	0.24	milling * mild social	9(12)	15(19)	10(13)	4(5)	14(16)	16(21)	10(13)	3 slaps		78
8/15	34"	15	0.16	milling * mild social	28(34)	6(7)	12(15)	3(4)	17(21)	2(2)	14(17)	1 slap aircraft		82
8/16	35"	40	0.02	milling * mild social	4(12)	9(3)	2(6)		4(12)	19(58)	3(9)	geo boat (distant)		41
8/18	30"	4	0.31	milling	21(57)	1(3)	13(35)		1(3)	1(3)		aircraft	tail slap fight	37
9/14	42"	1	3.40	resting	24(17)	16(11)	8(6)	15(10)	17(12)	17(12)	46(32)	none	unseen east?	143
9/15	60"	27	0.17	milling mild social	70(25)	63(23)	32(12)	58(21)	11(4)	27(10)	16(6)	BS	cow/calf nursing	277
9/18	90"	61	0.18	social feeding milling	175(17)	364(36)	60(6)	98(20)	55(5)	102(10)	60(6)	geo boat (distant)	5 slaps	1014
9/24	50"	8	0.83	social feeding	69(21)	64(19)	29(9)	56(17)	40(12)	12(4)	60(18)	none	whale displays; 5 slaps	330
9/25	10"	0	0			6(100)								6
				TOTAL	411 (20)	550(27)	168(8)	136(16)	164(8)	201(10)	214(10)			2044

Table XVIII. Results of initial aural analyses of bowhead sounds recorded in Fall 1982: #(%).

* = aircraft response

surface and (3) unable to observe behavior of whales below the surface. Behavioral observations were further constrained by time limitations and fuel budgeting when **flying** line transect surveys. Remaining in an area to observe whale behavior during sound recording sessions usually resulted in transect surveys being curtailed.

There is some indication based on the differential production of call types presented in Tables VI and XVIII that call type and rate may be at least generally correlated with behavior. More complex and trumpeting calls were recorded near whales that were mildly socializing (within a body length) or actively socializing (body contact) than near those whales noted as swimming only. Swimming, feeding and milling whales appeared to produce many simple moans and fewer complex **pulsive** sounds. These correlations are similar to those reported in Würsig et al. (1982). **Würsig** et al. went on to attribute "some general functions" to bowhead sounds based upon work conducted by Clark (1982) on southern right whales. Clark suggests that "up" **calls** were contact calls and result in whales joining; that "down" calls were contact calls that keep whales in acoustic range but did not result in joining, and that high FM and complex **pulsive** calls were often produced when whales were socially active. Though we are somewhat skeptical of interpreting bowhead acoustic data based on studies on a different (though closely related) species, a few broadly interpreted correlations may be drawn from our data in respect to these "general functions". "up" calls were prevalent in our spring sound samples (2 May), when whales were thought to be actively migrating and in two fall samples (7 and 18 August) when whales were milling. A tail slapping sequence was witnessed on 18 August, in which two bowheads repeatedly tail slapped at one another for approximately 10 min. Notably only one complex moan and no trumpeting sounds were recorded on that date, and all other sounds were simple moans, 21% being "up" calls. The high relative percentage of "up" calls in these samples may be related to bringing the whales in contact. On 16 September the greatest percentage of "down" calls were recorded from bowheads that appeared to be feeding. Such calls could have kept foraging whales in acoustic contact as they utilized a common food source. As previously mentioned, complex moans and trumpeting were common when whales appeared to be socializing, most dramatically so on 4 May, when it appeared mating was the

dominant activity. As yet, sound and behavior samples limit discussion to broad speculation. A detailed analysis of the sounds recorded this year is currently underway, and we hope to compare these sounds with those recorded in previous years and to approach a more rigorous sound and behavior correlation. Those results will be presented in a separate report.

Responses to Aircraft

Bowheads apparently responded to the aircraft on occasions even when it was as high as 600 m altitude (Figure 29). If they were quiescent they would respond by rising to the surface, blowing, swimming, or diving. If they were swimming, they would respond by abruptly changing their speed and/or direction, or by immediately diving. Twice whales were seen to congregate and dive synchronously after the approach of the aircraft (not necessarily in response to the aircraft). Calves responded by swimming towards, over or under the cow. Twice groups were observed to respond, when in the presence of a calf, by gathering around it. Occasionally, whales slapped their tails as the aircraft circled overhead. This may have been an overt display towards the presence of the aircraft.

In early August, a high percentage of the whales (97%, $n = 105$) appeared to react to the aircraft when the average flight altitude was 280 m. These animals were usually in deep water and heavy ice. In late September most (92%, $n = 277$) showed no detectable response to the aircraft. These whales were primarily in ice-free, shallower water and more appeared to be feeding. These apparent changes in tolerance to the aircraft occurred even though the average flight altitude increased to 320 m.

Bowhead Carcasses

Four bowhead carcasses were seen in the Beaufort and Chukchi Seas in September and October. The positions and comments on the condition of the carcasses are presented in Table XIX. We believe that the sightings of carcasses on 23 and 24 September were of the same animal because of size and similarity of white markings. However, other carcasses apparently were

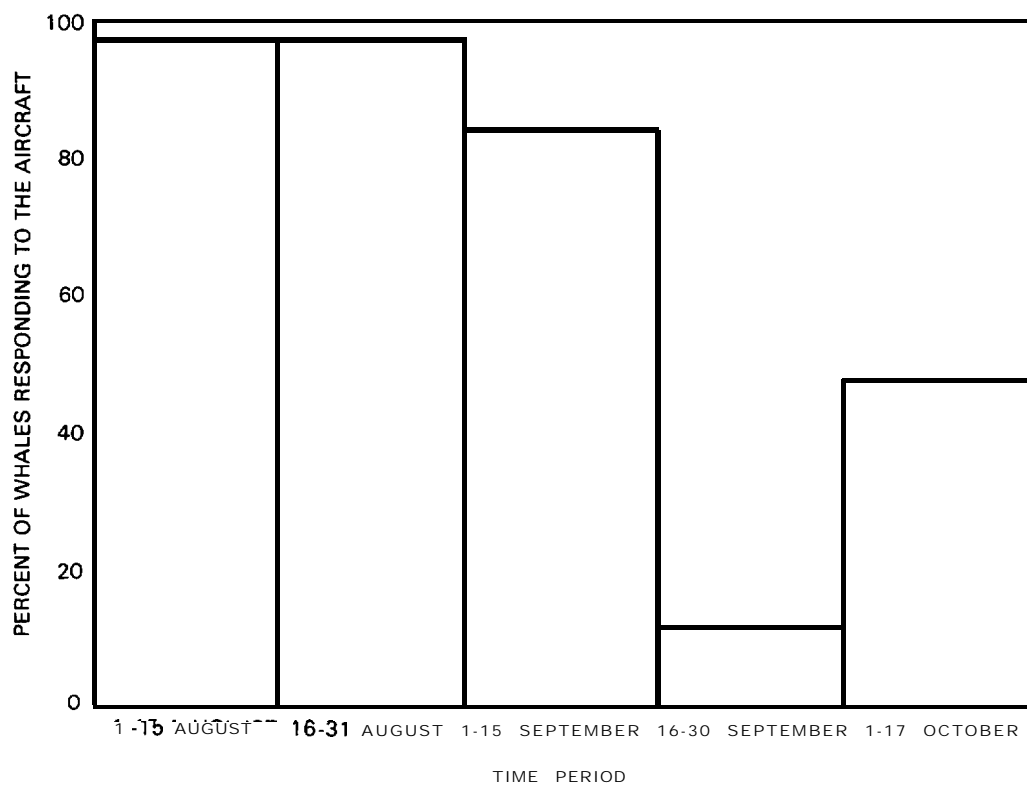


Figure 29. Bowhead aircraft response, fall 1982.

Date	Fit. No.	Aircraft	Position	Comment
9/23	69	N780	71°19.3'N 152°36.0'W	12.5 m (est); no visible chin patch; floating on left side; 60 km NW Cape Halkett in Beaufort Sea; many birds and bird feces on carcass.
9/24	24	N642	71°09.2'N 152°23.1'W	12.5 m (est); tongue bloated; floating on left side; 35 km NNW Cape Halkett in Beaufort Sea; many birds on carcass.
9/28	73	N780	71°09.6'N 154°13.9'W	13.0 m (est); small white chin patch; floating ventral side up; 25 km NE Cape Simpson in Beaufort Sea; many birds attracted to carcass.
1 0/3	77	N780	70°54.6'N 160°09.7'W	16.5 m (est); large white chin patch; floating on right side; 50 km W Pt. Franklin in Chukchi Sea; many birds attracted to carcass.

Table XIX. Locations of bowhead whale carcasses.

unique. One of the whales encountered in the Beaufort Sea between 23 and 28 September may have been a whale struck and lost by Kaktovik hunters on 15 September.* Additionally, a whale pulling a float and apparently wounded was observed on **17 September 70** km northwest of Brownlow Pt. by observers on board the bowhead behavior observation plane N642 (Ljungblad et al., 1983).

Two tissue samples were obtained from a bowhead on Narwhal Island taken by **Nuiqsut** hunters. They were transferred for analysis to the University of Guelph.

*personal communication, Craig George, North Slope Borough, Barrow, AK.

Other Species

Gray Whales (Eschrichtius robustus)

We saw gray whales swimming and feeding south of Barrow as late as 3 October. Twenty-six whales were seen from 28 September to 11 October. Though gray and bowhead whales were seen the same flight (Flights 73, 76, 77), there was no apparent overlap in their distribution. Grays were generally southwest of bowheads. The closest proximity observed was about 50 km on 3 October (Flight 77).

Belukha whales (Delphinapterus leucas)

Belukha whales were found in early August closely associated with the ice between 71°N and 72°N latitude distributed along the continental shelf break in up to 2000 m deep water. They were sometimes associated with bowhead whales but usually were seen west and north of the bowheads. Few were seen in open water. Though belukhas were seen with bowheads migrating in early August, no belukha whales were seen in September as the bowhead whale migration moved nearer to shore. The overall distribution of our 1982 belukha sightings is presented in Figure 30. A large group of approximately 250 belukhas was seen on 17 October about 70 km northeast of Pt. Barrow (71°34.1'N, 156°14.6'W), near an area where the large belukha concentrations were seen in spring (Flight 14).

As previously indicated, the spring and fall migrations of belukha whales appear to roughly coincide both spatially and temporally with the bowhead migrations. Belukhas appear to be largely transient in the Chukchi Sea. Except for whales found in Kotzebue Sound and Escholtz Bay in 1981, belukha whale sightings in the Chukchi Sea have occurred only during migratory periods. The Beaufort Sea appears to be primarily a summer feeding area at the north and east end of the migration route.

The area, approximately 60 km northeast of Pt. Barrow (near 71°50'N, 156°00'W) with a water depth of 100-250 m, appears to be an important area for belukha whales. We have repeatedly seen large aggregations of between 250-600

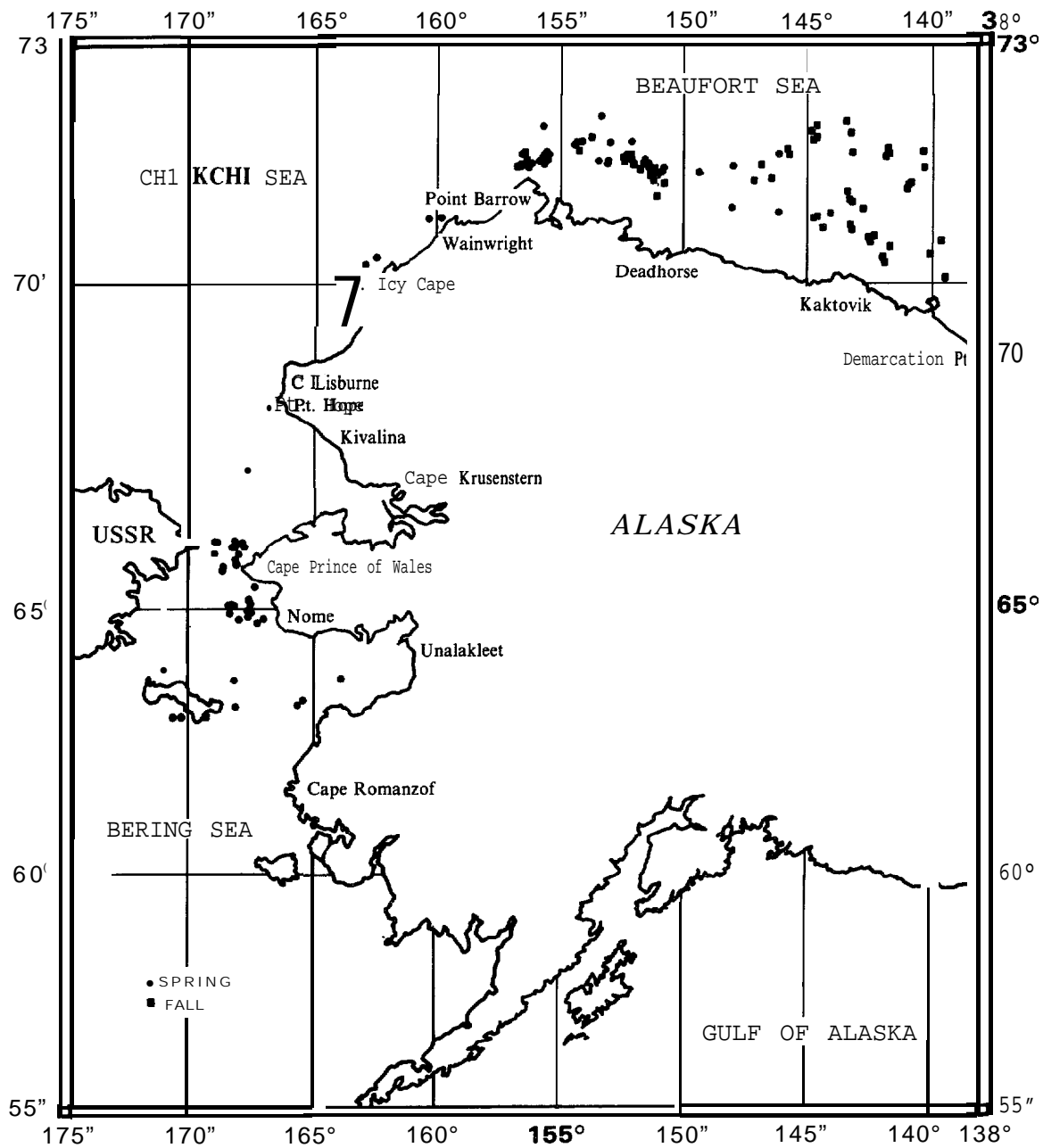


Figure 30. Overall distribution of belukha whale sightings representing 2139 whales, spring and fall, 1982.

animals in this area in spring and fall. The importance of this area remains unclear, though other investigators* have reported seeing similar large concentration of whales near this area, and feeding has been suggested as the reason for their concentrating there.

Unidentified Cetaceans

An unidentified cetacean was seen on 2 October. This whale may have been a bowhead or a gray, but was too far away for positive identification.

pinnipeds

Unidentified pinnipeds were seen frequently in mid-September near the 50-m to 100-m isobath of Harrison and Smith Bays. By early October, ringed seals (Pusa hispida) were observed near holes they had made in the new ice north of Pt. Barrow and into the Chukchi Sea. Over 350 walruses (Odobenus rosmarus) were seen in the Chukchi Sea on 9 October hauled out on ice. There were many pups in these groups. Nearly 70 walruses were counted swimming in open water between Pt. Hope and Pt. Lay on 11 October. About 90% of the walruses that were hauled out or swimming reacted to our aircraft by diving. Approximately 80% of the ringed seals and 70% of the bearded seals (Erignathus barbatus) also exhibited this positive response to the aircraft.

Polar Bears (Ursus maritimus)

Twenty-one polar bears were seen this fall at positions ranging from about 70 km northwest of Pt. Barrow to 130 km northeast of Barter Island. Their sighting positions are provided in Table XX. All bears except one were initially seen on the ice or shore and all responded to the aircraft by running and occasionally diving into the water and swimming away. No radio collars or tags were visible on any of the bears observed.

*Personal communication, J. Burns, 1982, Alaska Department of Fish and Game, Fairbanks, AK.

Date	Fit. No.	Position	No. Bears (n=21)
6 Aug	36	70 20.3N 44 42.6w	1
7 Aug	37	71 57.2N 42 21.5w	1
		70 55.4N 43 07.9W	1
15 Aug	43	70 34.5N 43 27.7W	1
		71 36.4N 42 26.5w	1
		71 36.6N 142 26.4w	1
16 Aug	44	70 29.8N 141 40.7W	1
8 Sep	61	71 03.2N 141 19.8W	1
18 Sep	67	7? 12.3N 151 32.3w	1
24 Sep	70	70 32.4N 149 24. 0W	1
9 Ott	81	71 43.7N 155 38.3w	2
12 Ott	84	71 53.8N 161 37.4W	1
		71 36.4N 156 45.1W	2
15 Ott	85	71 54.1N 141 22.9W	2
11 oct*	90	70 35.0N 149 47.0W	1
15 oct*	94	71 01.0N 148 26.0W	3

(* = N642 crew sightings)

Table XX. Location of polar bears seen in fall 1982.

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APPENDIX A

AERIAL SURVEY FLIGHT TRACKS AND SIGHTING CHARTS, 1982

This appendix consists of flight tracks 1 through 94, which cover surveys in the northern Bering, eastern **Chukchi**, and Beaufort Seas during the period mid-April to **mid-October 1982**. **Table A-1 summarizes marine mammal sightings** by species and season, **Figure A-1, a map of Alaska that also depicts the overall 1982 flight effort, is provided for reader orientation.**

Each flight is represented by a flight track/sighting chart and a descriptive caption. Each symbol on the flight track/sighting charts represents one sighting of one or more animals. * Flight track captions also describe the general conditions observed, and a **summary table of sighting positions, conditions, and behavior is provided for flights on which bowheads were seen.** These summary tables have the following format:

T#/C# - Total number and number of calves seen
LAT/LONG - Location (latitude/longitude)
DIS(M) - Perpendicular distance from the aircraft in meters
CUE Sighting cue (**BO=Body**, **BW=Blow**, **WD=Water Disturbance**, **SP=Splash**, **BF=Birds/Fish**, **MP=Mud Plumes**, **OS=Oil Slick**, **KS=Kill Site**, **NA=None**).
BEH Behavior (**SW=Swim**, **DI=Dive**, **RE=Rest**, **MI=Mill**, **GS or SS=Stationary**, **MT=Mate**, **FE=Feed**, **CC=Cow-Calf**, **SH=Spyhop**, **UB=Underwater Blow**, **FS=Flipper Slap**, **TL=Tail Lob**, **BR=Breach**, **DD=Dead**, **NA=None**).
HDG Heading in magnetic degrees
ICE Ice coverage in tenths
SS Sea State (Beaufort scale)
DEPTH(M) - Depth in meters

* Anglicized spelling of "belukha" (beluga) is used in key for the flight track/sighting charts.

SPECIES	ABR .	SPRING	SUMMER	FALL	TOTAL
Bowhead whale (<u>Balaena mysticetus</u>)	BH	265	0	490 (3D)	755
Belukha whale (<u>Delphinapterus leucas</u>)	BE	1651	3 (1D)	485	2139 (1D)
Gray whale (<u>Eschrichtius robustus</u>)	GW	2	320 (6D)	26	348 (6D)
Minke whale (<u>Balaenoptera acutorostrata</u>)	MW	0	1	0	1
Narwhal (<u>Monodon monoceros</u>)	NW	2	0	0	2
Walrus (<u>Odobenus rosmarus</u>)	WS	2900	100 (280D)	458	3458 (280D)
Bearded seal (<u>Erignathus barbatus</u>)	BS	173	2	22	197
Ringed seal (<u>Pusa hispida</u>)	RS	41	0	71	113
Polar bear (<u>Ursus maritimus</u>)	PR	2	0	17	23
Unidentified cetacean	CT	0	1	1	2
Unidentified pinniped	PN	0	84	461	545

Table A-1. Species summary. Abbreviations and totals observed by season.

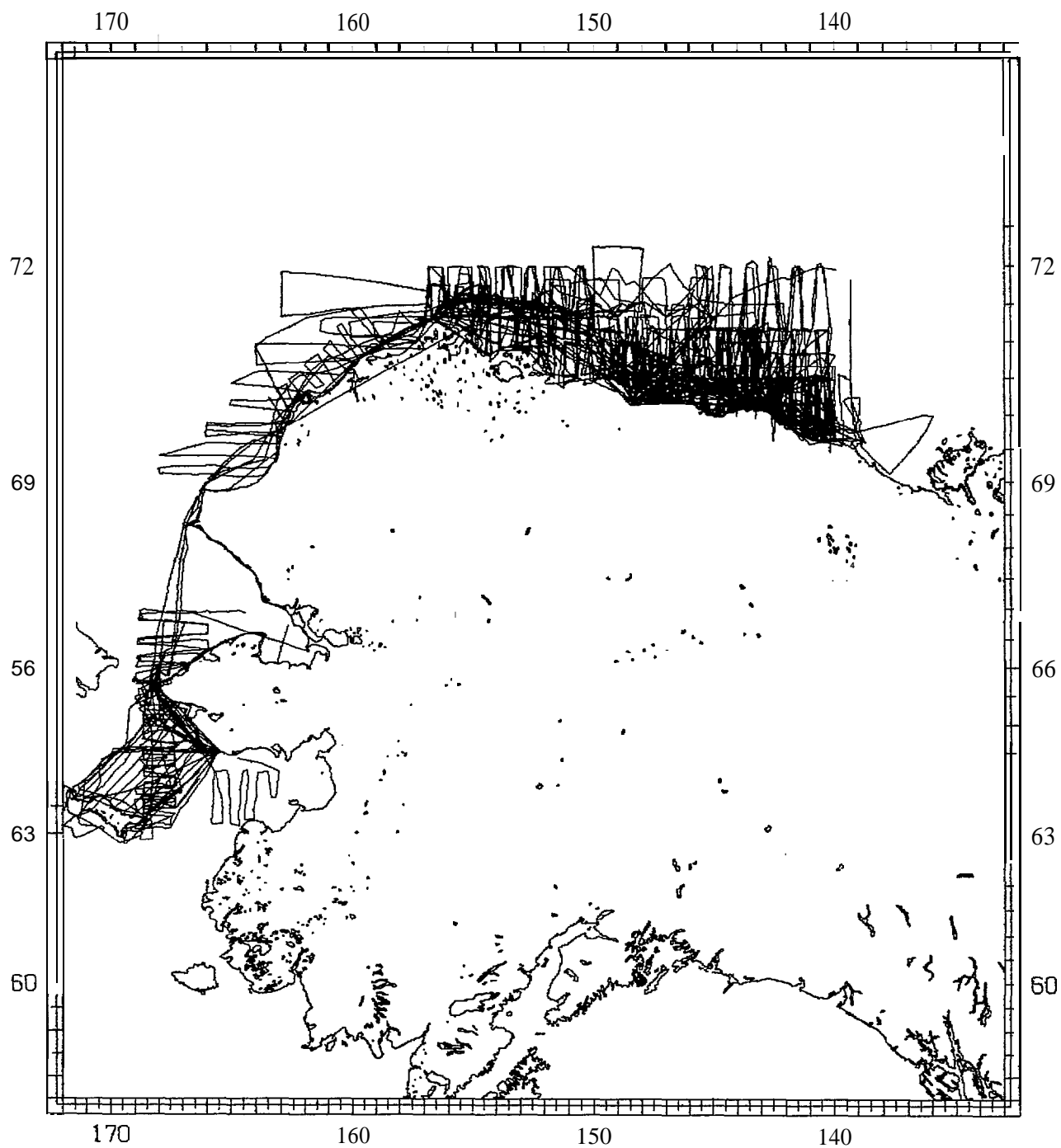
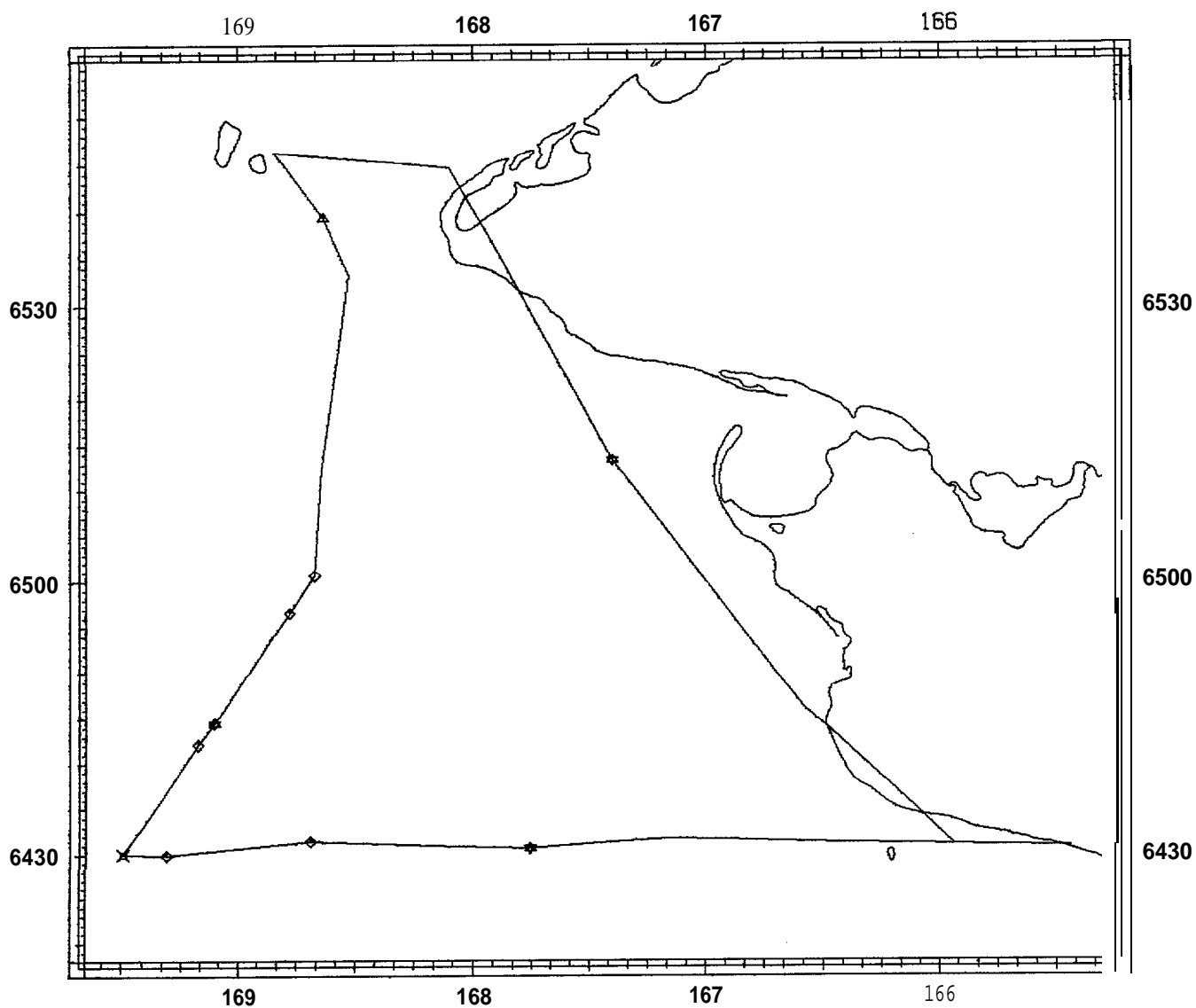


Figure A-1 . Overall flight effort, 1982.

KEY FOR FLIGHT 1

- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ★ (BEARDED SEAL)
- ◇ (WALRUS)

Flight #1, 23 April, 1982



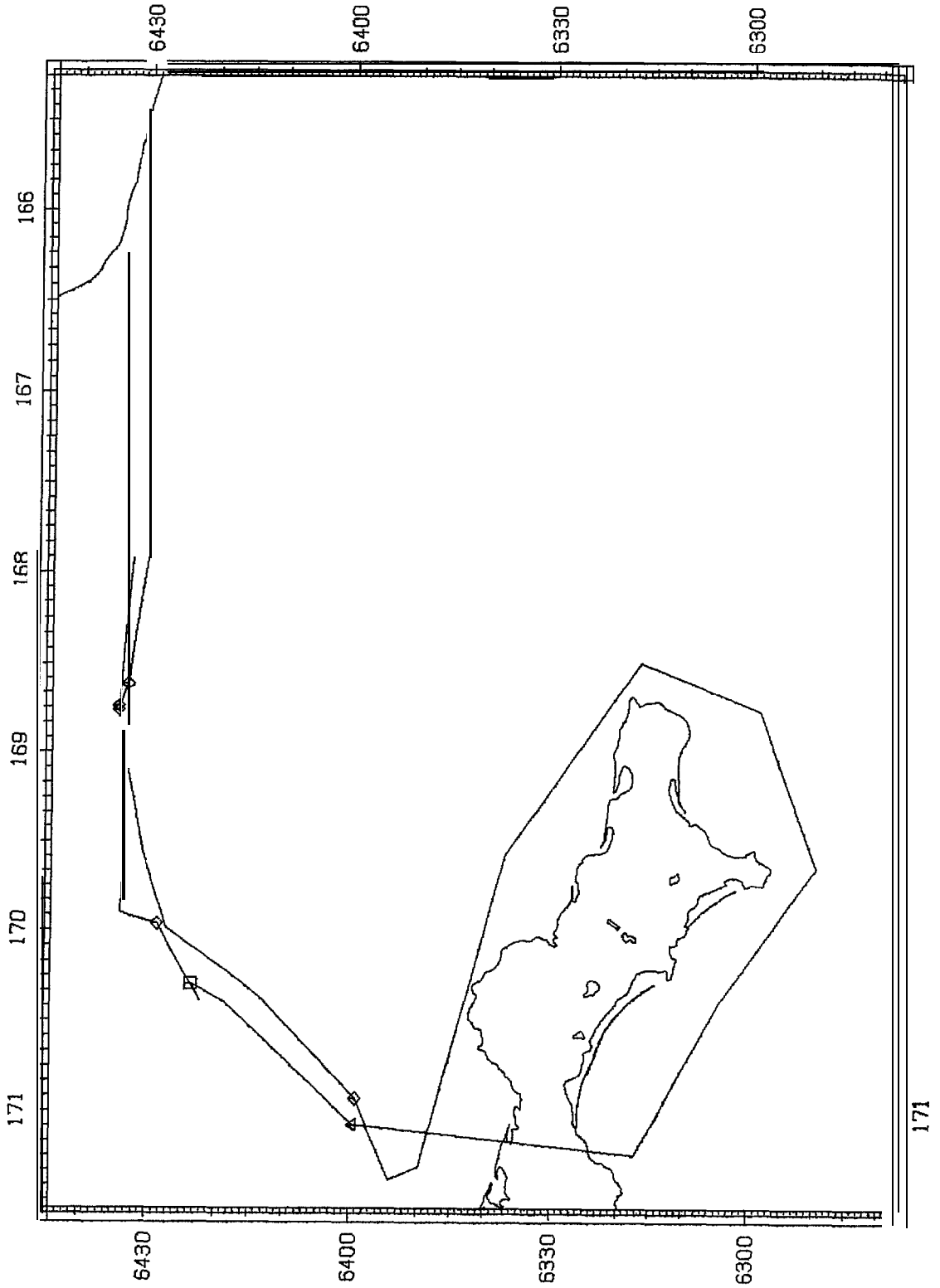
Flight #1, 23 April 1982

Flight was a search survey to and south of the Bering Strait. Weather was hazy. Visibility was generally unlimited. Ice coverage was 8/10 to 9/10 broken floe and new ice. Sea state was Beaufort 00 to 02. No bowhead whales were sighted. Belukha whales, bearded seals, ringed seals and walrus were seen.

KEY FOR FLIGHT 2

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ◇ (WALRUS)

Flight #2, 24 April, 1982



Flight #2, 24 April 1982

Flight was a search survey near St. Lawrence Island. The weather was clear. Visibility was generally unlimited. Ice coverage was 8/10 to 9/10 broken floe ice. Sea state was Beaufort 00 to 03. Two bowhead whales were sighted in a wide lead north of St. Lawrence Island. Belukhas and walrus were also sighted. A sonobuoy was dropped but no sounds were recorded.

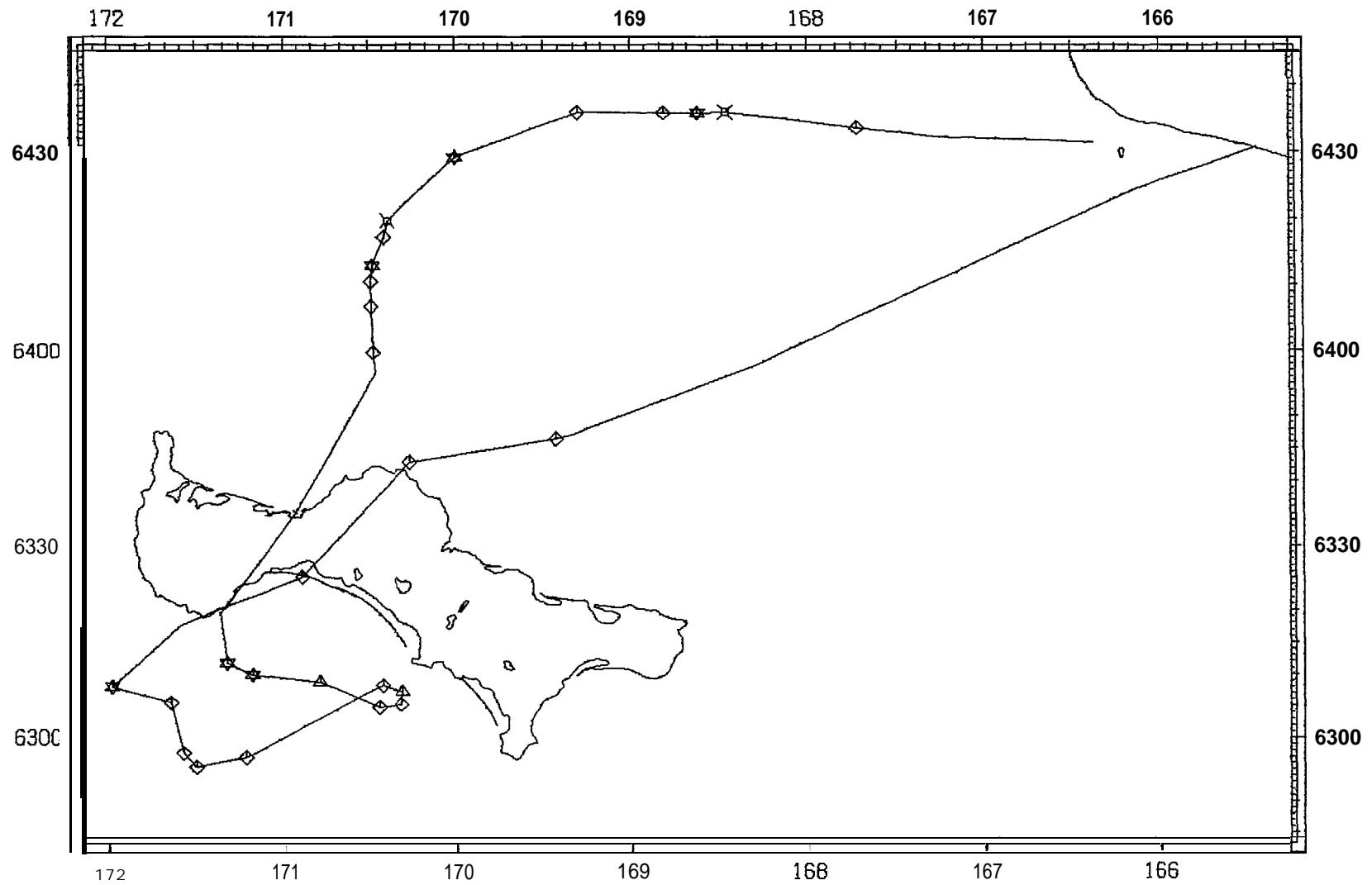
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HOG	ICE	SS	DEPTH(M)
2/0	64°23.5'	170°17.8'	1023.3	NA	NA	NA	1	3	41

KEY FOR FLIGHT 3

- △ (BELUGA WI-FILE)
- ✕ (RINGED SEAL)
- ★ (BEARDED SEAL)
- ◇ (WALRUS)

Flight #3, 25 April, 1982

A-10



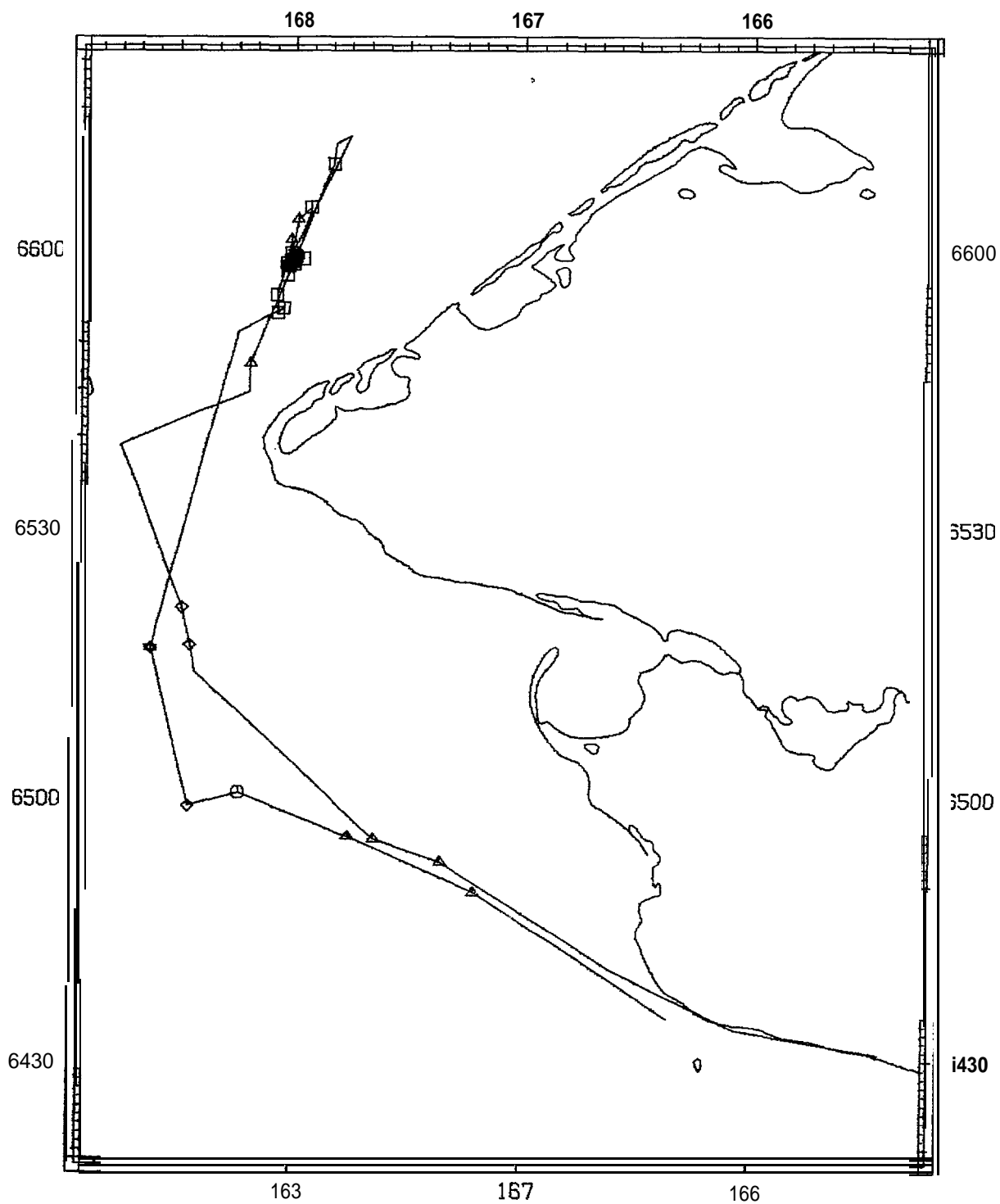
Flight #3, 25 April 1982

Flight was a search **survey** near St. Lawrence Island. The weather was clear. Visibility was generally unlimited. Ice coverage was 8/10 to 9/10 broken floe and new ice. Sea state was Beaufort 00 to 01. No bowheads were sighted. **Belukhas**, bearded seals, ringed seals and walrus were seen.

KEY FOR FLIGHT 4

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✱ (BEARDED SEAL)
- ◇ (WALRUS)
- ⊙ (RINGED SEAL)

Flight #4, 26 April, 1982



Flight #4, 26 April 1982

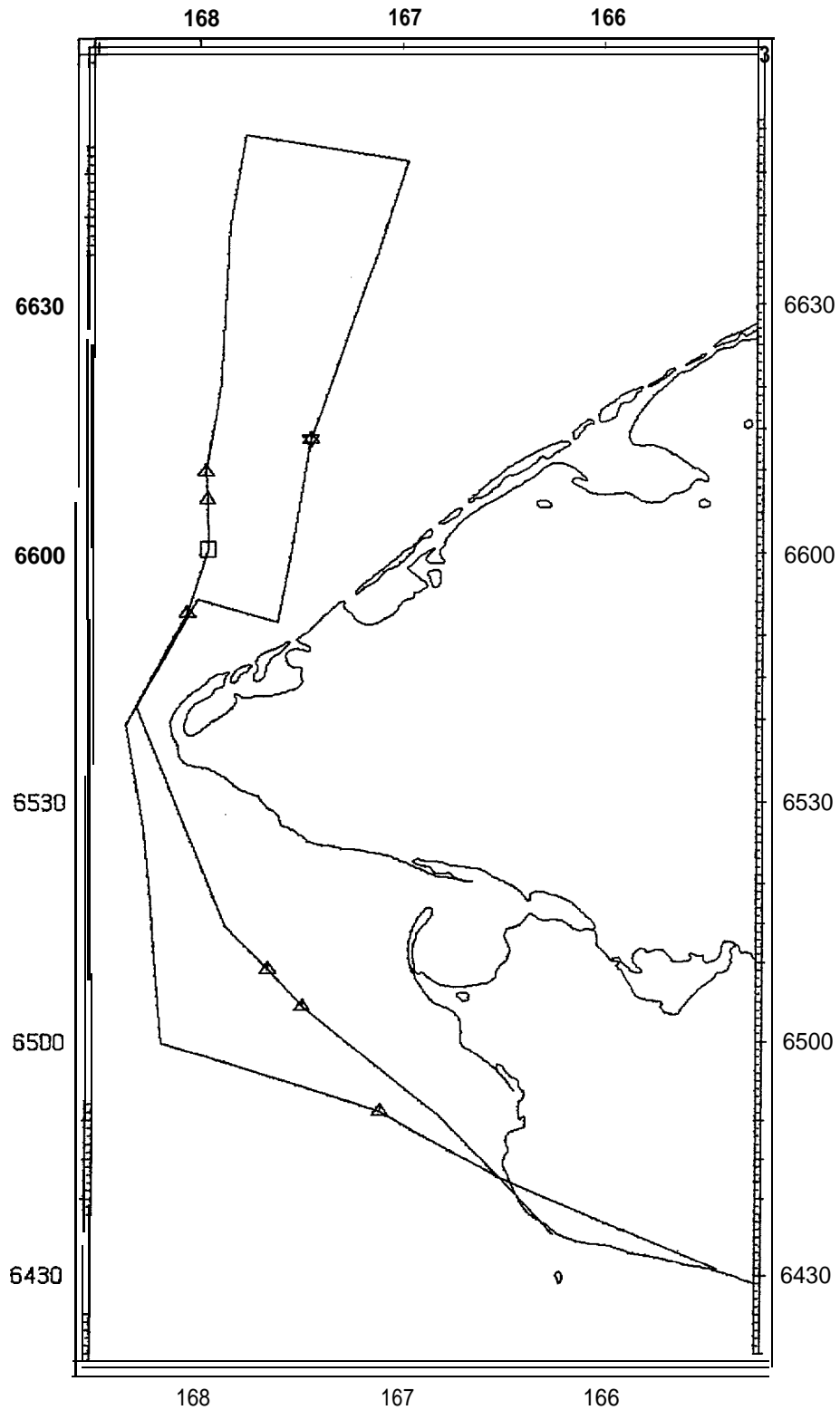
Flight was a search survey north of the Bering Strait. The weather was clear. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 00 to 02. Twenty-eight bowheads north of the Bering Strait were sighted and their sounds were recorded via sonobuoy. Two narwhals were sighted north of King Island. Belukhas, bearded seals, ringed seals and walrus were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	65°58.6'	168°00.5'	179.1	BO	RE	350	5	3	37
1/0	65°58.8'	168001.1'	528.1	BO	RE		5	3	37
2/0	65°59.0'	167°57.7'	837.6	BO	RE		5	3	37
3/0	65°59.3'	167°59.9'	586.4	BO	RE		5	3	37
2/0	65°59.2'	167°59.8'	254.3	BO	RE		5	3	37
3/0	65°58.2'	168°01.5'	105.6	BO	RE		5	3	37
1/0	65°59.6'	168°01.0'	422.5	BO	Sw		5	3	37
3/0	66°04.4'	167°55.8'	1729	BO	DI		5	3	37
1/0	65°58.4'	168000.1 '	837.6	BW	DI	350	4	3	37
1/0	65°58.9'	168000.1 '	255.8	BO	Sw		4	3	37
3/0	65°57.2'	168°02.0'	1729	BO	Sw		4	3	37
1/0	66°09.1'	167°49.7'	102.3	BO	DI		4	3	37
2/0	65°58.5'	168°02.2'	NA	BO	DI		9	3	37
1/0	65055.1 '	168°04.8'	528.1	BO	RE	350	8	3	37
2/0	65°53.2'	168°04.4'	NA	BO	GM		7	3	37
1/0	65°53.7'	168°02.9'	1434.3	BO	Sw		7	3	37

KEY F(3R FLIGHT 5

Flight #5, 27 April, 1982

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ★ (BEARDED SEAL)



Flight #5, 27 April 1982

Flight was a search survey north of the Bering Strait to 66°50' latitude. The weather was overcast and windy. Visibility was generally less than 10 km. Ice coverage was 9/10 to 10/10 broken flow and new ice. Sea state was Beaufort 02 to 05. One bowhead whale, **belukha** whales and a bearded seal were sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
1/0	66°00.5'	167°57.0'	1735.5	BO	DI	340	6	3	37

KEY FOR FLIGHT 6

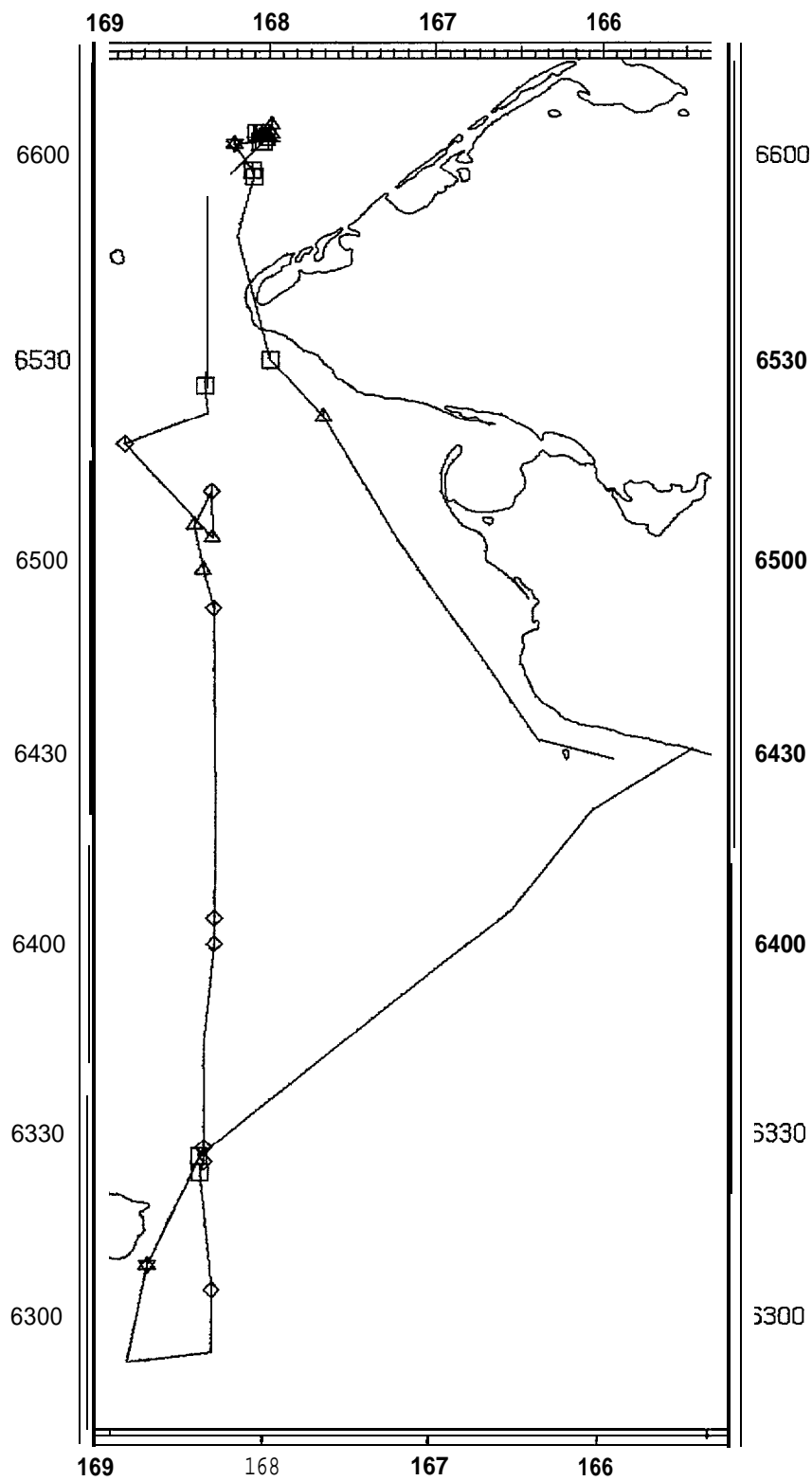
□ (BOWHEAD WHALE)

△ (BELUGA WHALE)

☆ (BEARDED SEAL)

◇ (WALRUS)

Flight #6, 29 April, 1982



Flight #6, 29 April 1982

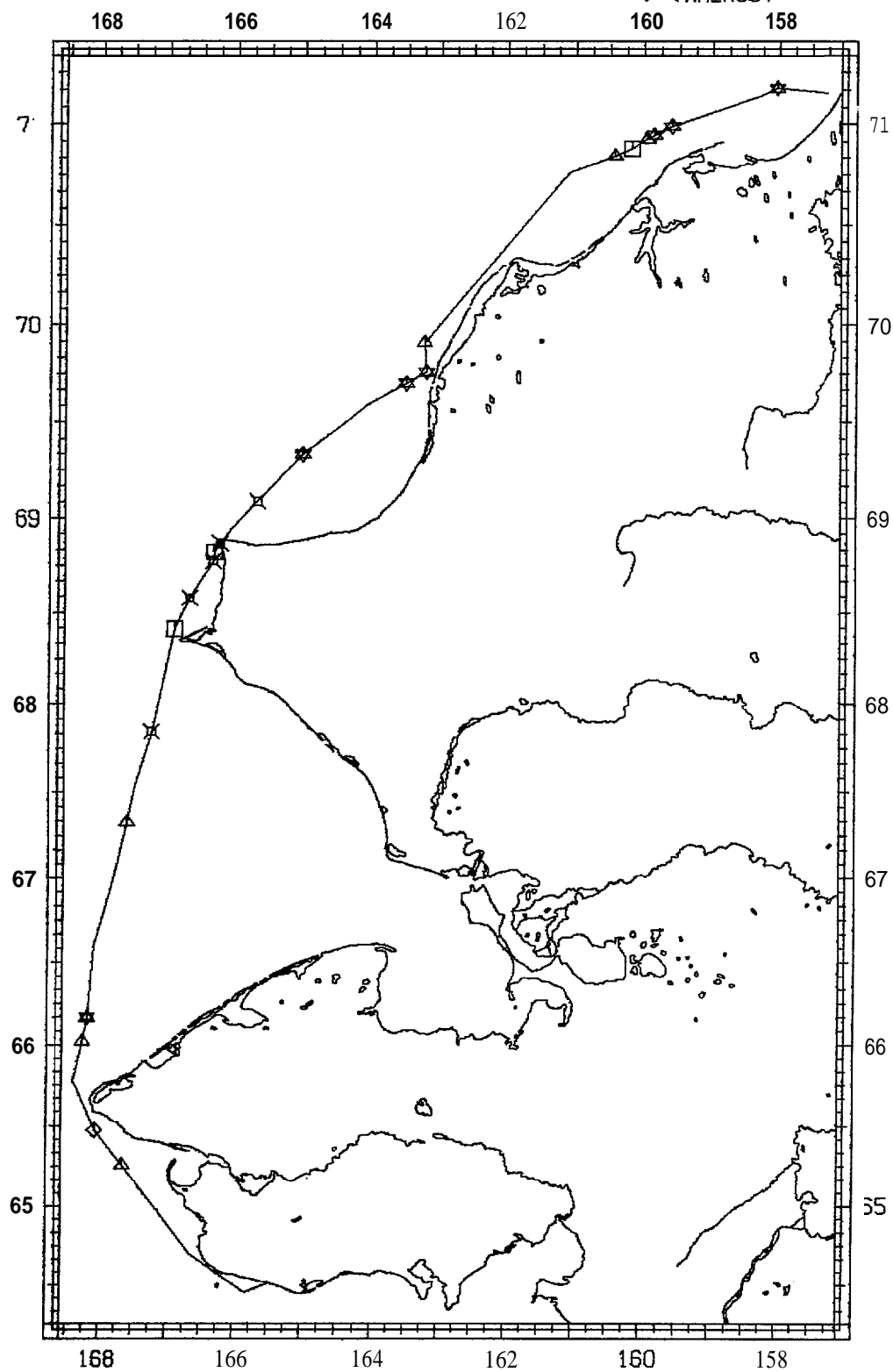
Flight was a search **survey** east and north of St. Lawrence Island and through the Bering Strait. The weather was clear. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 01. Thirteen bowheads were sighted east of St. Lawrence Island and near Bering Strait and their sounds recorded via **sonobuoy**. **Belukhas**, bearded **seals** and walrus were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	63°26.0'	168°23.5'	1056.1	BO	Sw	360	8	1	27
1/0	63°23.4'	168°22.9'		BO	Sw		8	1	27
1/0	65°26.0'	168°22.5'		BO	Sw	060	9	1	47
1/0	66°01.9'	168°02.6'		BO	DI	350	8	1	40
1/0	66°03.2'	168°02.5'		BO	DI	010	9	1	40
1/0	66°02.6'	168°00.6'		BO	DI		9	1	40
1/0	66°03.2'	168°04.3'		BO	RE		9	1	40
1/0	66°01.9'	168°02.9'		BO	Sw		9	1	40
1/0	65°57.7'	168°05.7'		BO	Sw		9	1	40
2/0	65°56.8'	168°40.9'		BO	Sw	350	9	1	56
2/0	66°30.0'	167°95.1'		BO	DI	180	7	1	33

KEY FOR FLIGHT 7

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ☆ (BEARDED SEAL)
- ◇ (WALRUS)

Flight #7, 1 May, 1982



Flight #7, 1 May 1982

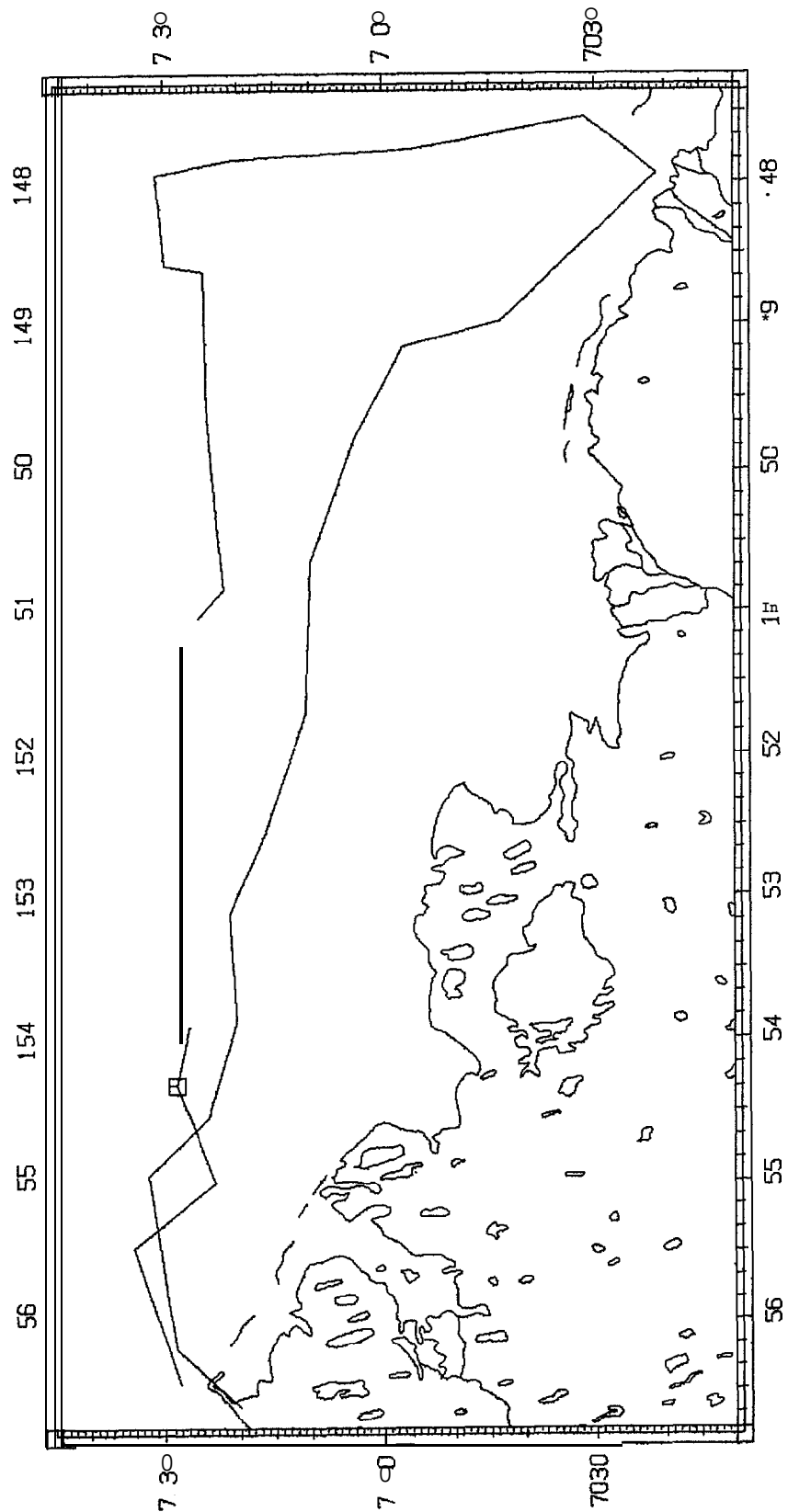
Flight was a coastal search survey from Nome to Pt. Barrow. The weather varied from clear to overcast. Visibility was generally over 10 km. Ice coverage was 9/10 to 10/10 broken flow ice. Sea state was Beaufort 01. Three bowheads, **belukhas**, bearded seals, ringed seals and walrus were sighted in the near-shore lead in the Chukchi Sea.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
1/0	68°24.8'	166°55.2'		NA	NA		10	0	11
1/0	68°49.3'	166°19.8'		BO	RE	090	9	1	9
1/0	70°52.9'	160°10.5'		BO	SS		9	1	27

KEY FOR FLIGHT

POOR BEAR

Flight #8, 2 May, 1982



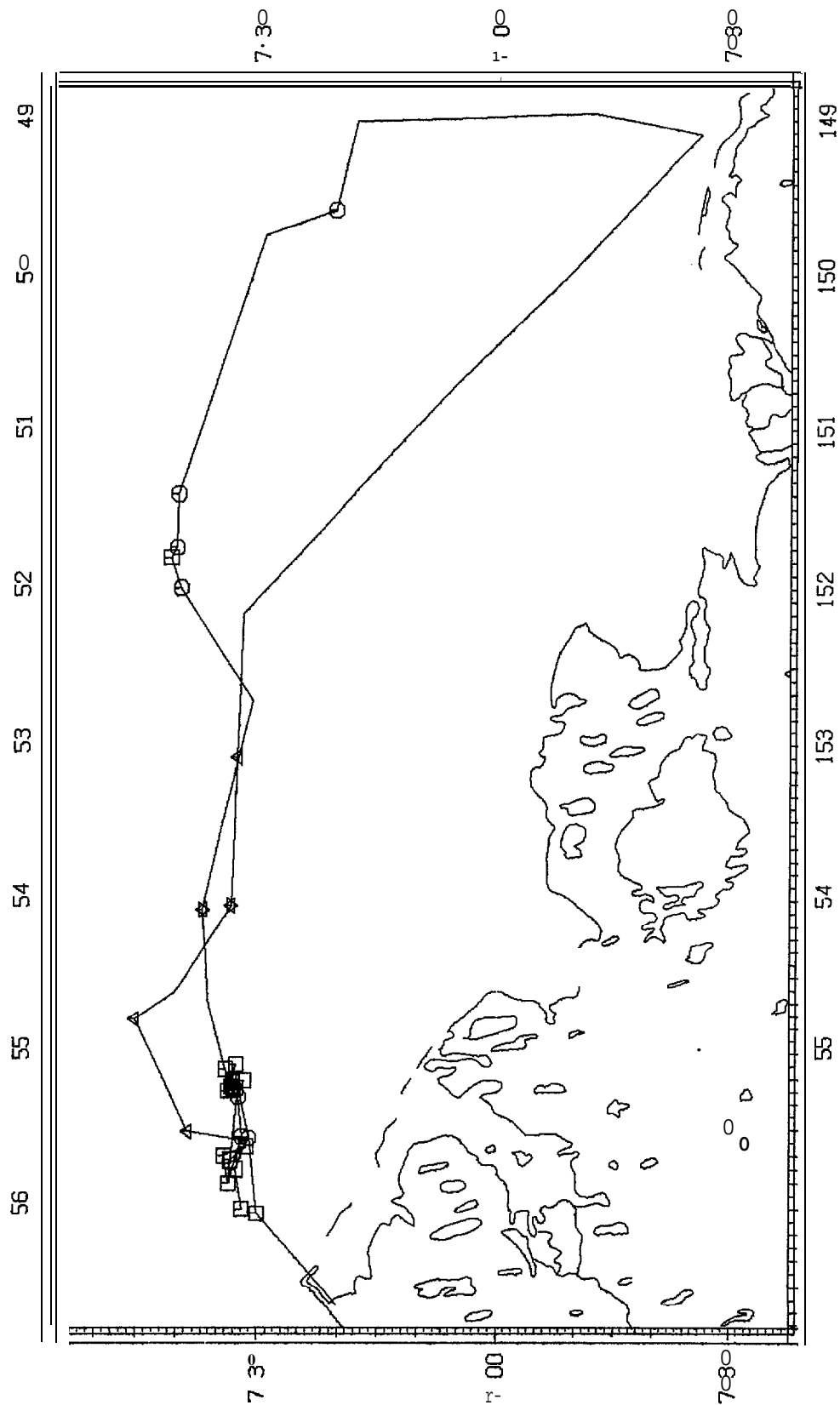
Flight #8, 2 May 1982

Flight was a search survey east of Pt. Barrow roughly along the 71°30'N latitude line to Deadhorse and return. The weather was patchy fog. Visibility was generally less than 10 km. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 00 to 02. No bowheads were sighted. One polar bear was the only marine mammal seen. One **sonobuoy** was dropped.

KEY FOR FLIGHT 9

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ★ (BEARDED SEAL)
- (NO SIGHTING)

Flight #9, 3 May, 1982



Flight #9, 3 May 1982

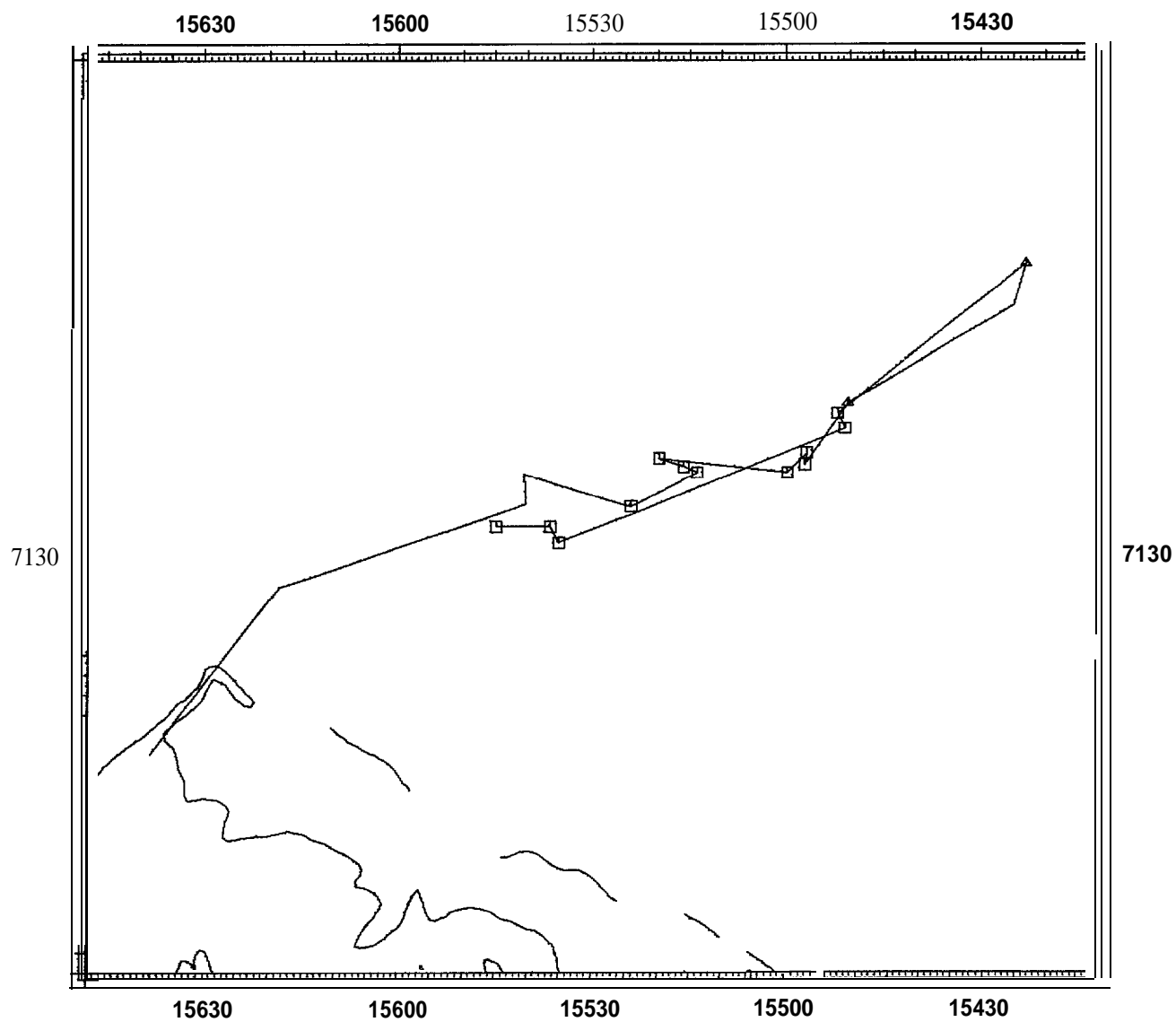
Flight was a search survey east of Pt. Barrow including the Federal Lease Area. The weather was clear. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 01. Thirty-six migrating bowheads were sighted northeast of Pt. Barrow and recorded via sono-buoy. Bearded seals and belukhas were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	71030.1'	156°01.7'		BO	Sw		9	1	22
2/0	71°33.4'	155°41 .5'		BO	Sw	060	8	1	36
1/0	71031.4'	155°36.5'		BO	Sw		8	1	22
1/0	71°34.2'	155°40.0'		BO	Sw		8	1	109
1/0	71°33.6'	155050.1 '		BO	Ss		8	1	24
3/0	71°31.7'	155010.7'		BO	Sw		8	1	20
3/0	71033.1'	155011.0'		BO	Sw		8	1	37
1/0	71°32.7'	155°13.6'		BO	Sw		8	1	20
5/0	71033.1'	155010.4'		BO	Sw	070	8	1	27
5/0	71°33.3'	155°13.2'		BO	Sw		8	1	36
1/0	71°32.7'	155°04.5'		BO	Sw		8	1	36
5/0	71°33.7'	155°14.7'		BO	Sw		8	1	21
1/0	71°33.0'	155014.4'		BO	Sw	060	8	1	18
2/0	71°34.0'	155°06.4'		BO	Sw		8	1	36
1/0	71°40.9'	151047.7'		BO	Ss		9	1	915
2/0	71°32.7'	155°44.8'		BO	Sw	060	8	1	18
1/0	71°32.0'	156°00.0'		BO	Sw		8	1	22

KEY FOR FLIGHT "10"

Flight #10, 4 May, 1982

• I (BOWHEAD WHALE)
A (BELUGA WHALE)



Flight #10, 4 May 1982

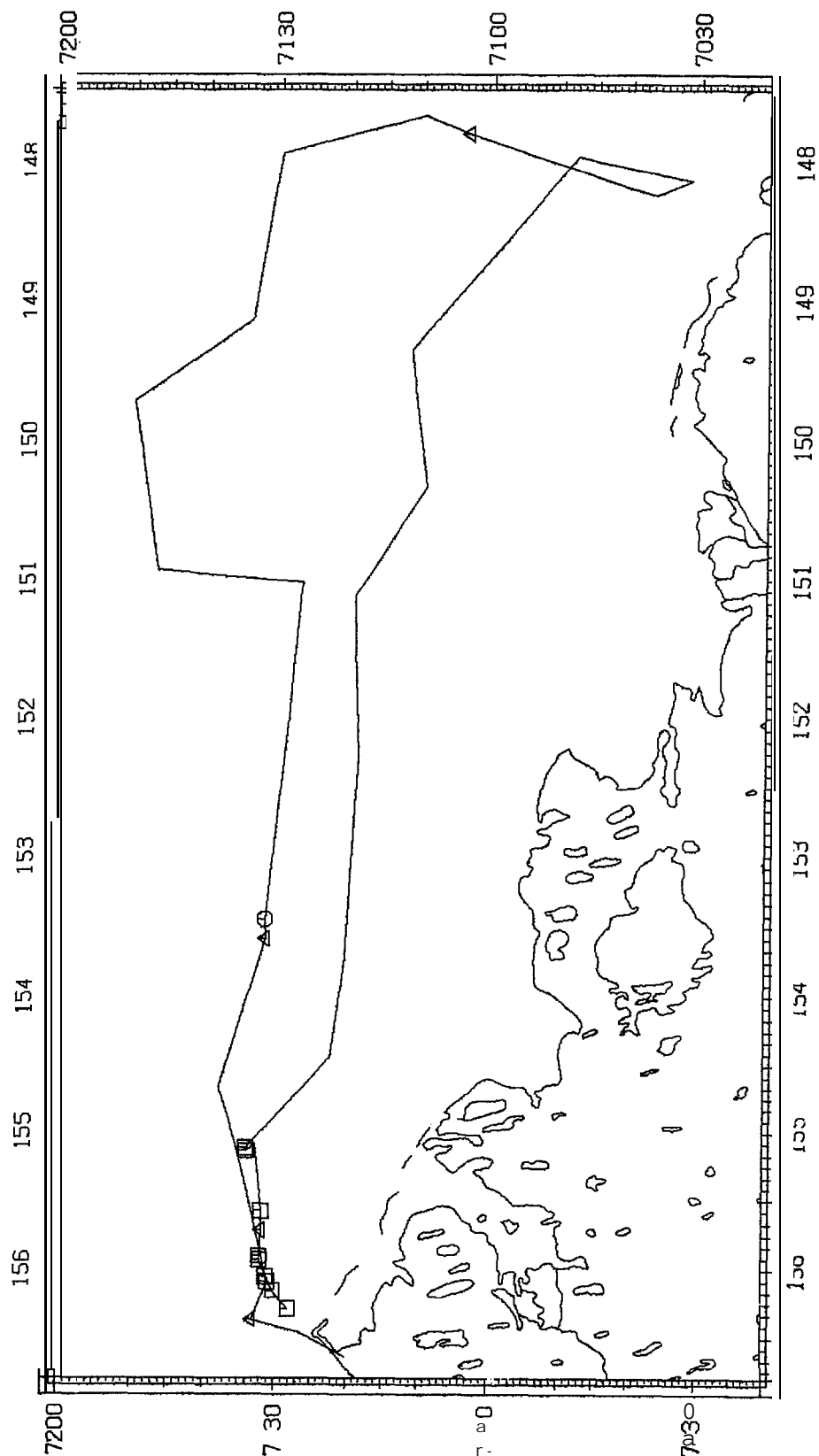
Flight was a search and behavioral observation survey north east of Pt. Barrow. The weather was clear. Visibility was generally unlimited. About 7/10 broken floe ice surrounded the shore fast lead. Sea state was Beaufort 00 to 02. Thirty-three bowheads were sighted northeast of Pt. Barrow. Social behavior, including possible mating, was observed and sounds recorded via sonobuoys. Belukhas were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH (M)
2/0	71°32.4'	155024.1 '		BO	Sw	040	7		18
3/0	71034.1'	155°13.8'		BO	GM		7		55
2/0	71°34.4'	155°15.9'		BO	GM		7		57
3/0	71°34.8'	155°19.8'		BO	BR		7		46
1/0	71034.1'	154059.7'		BO	Ss		7		42
2/0	71035.1'	154°56.7'		BO	Sw	030	9		33
1/0	71034.5'	154°57.0'		BO	Ss		9		42
1/0	71037.0'	154°51.9'		BO	Sw		9		44
1/0	71°36.3'	154°50.9'		BO	DI		9		44
5/0	71°30.6'	155035.1'		BO	MT		9		18
2/0	71°31.4'	155°36.5'		BO	Sw		9		16
1 0/0	71°31.4'	155°44.8'		BO	GM		9		18

KEY FOR FLIGHT 11

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- (NO SIGHTING)

Flight #11, 5 May, 1982



Flight #n, 5 May 1982

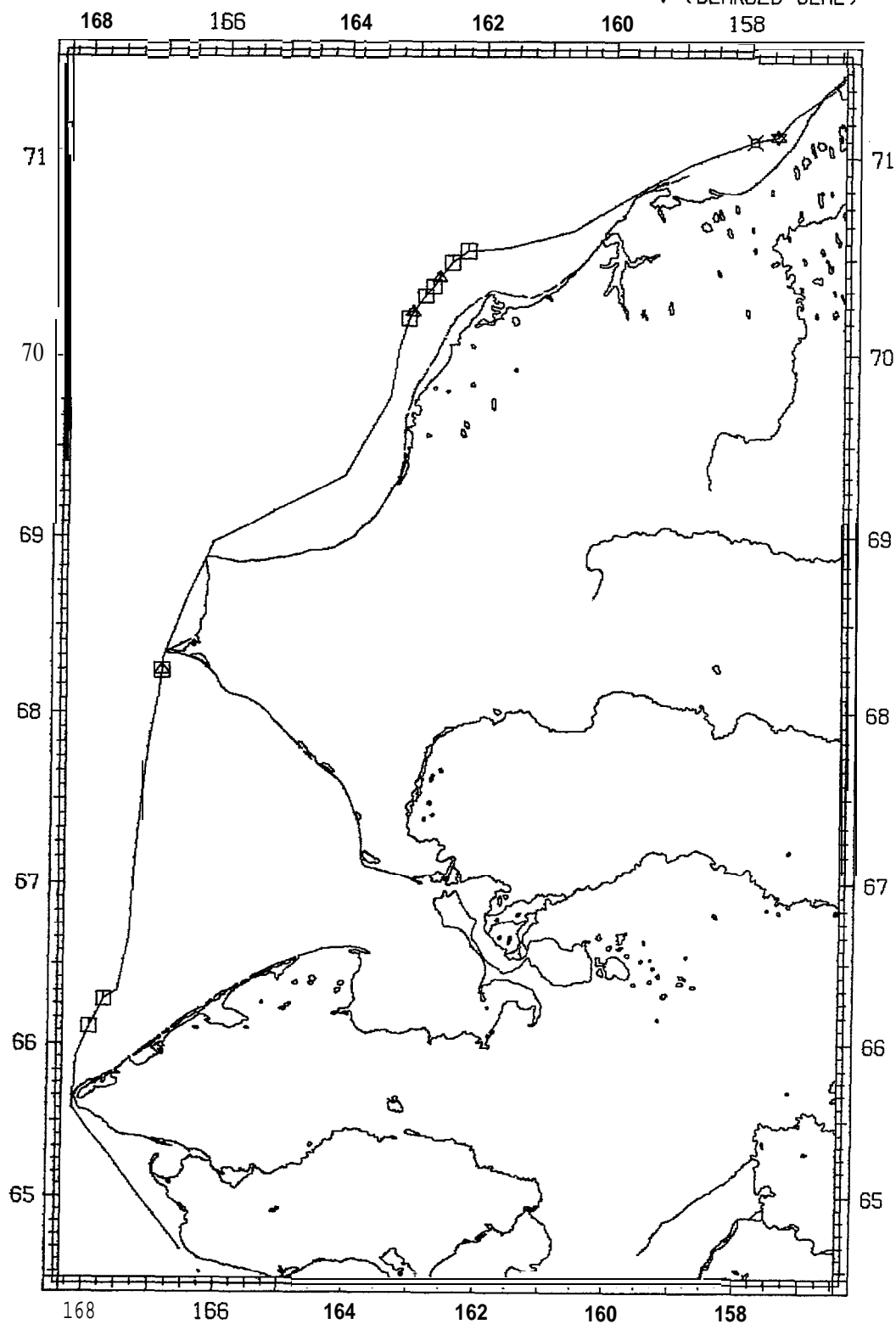
Flight was a search survey between Pt. Barrow and Deadhorse including the Federal Lease Area. The weather was clear. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 00 to 02. Eleven bowheads were sighted northeast of Pt. Barrow. Most were actively migrating and their sounds were recorded via **sonobuoys**. **Belukhas** were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(NM)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	71°31.0'	156°05.2'		BO	Ss	120	9	1	18
2/0	71°31.2'	156°02.9'		BO	DI		9	1	18
1/0	71°34.1'	155°06.9'		BO	Ss	030	9	1	18
1/0	71°34.0'	155°08.0'		BO	Ss		9	1	18
1/0	71°31.9'	155°34.6'		BO	Ss	050	9	1	18
1/0	71°32.2'	155°53.8'		BO	Ss	050	9	1	18
2/0	71°32.1'	155°55.4'		BO	Sw		9	1	20
1/0	71°30.2'	156°09.0'		BO	Ss		9	1	18
1/0	71°28.1'	156°17.2'		BO	Ss		9	1	18

Flight #12, 7 May, 1982

KEY FOR FLIGHT 12

- (BOWHERD WHALE)
- A (BELUGA WHALE)
- X (RINGED SEAL)
- ☆ (BEARDED SEAL)



Flight #12, 7 May 1982

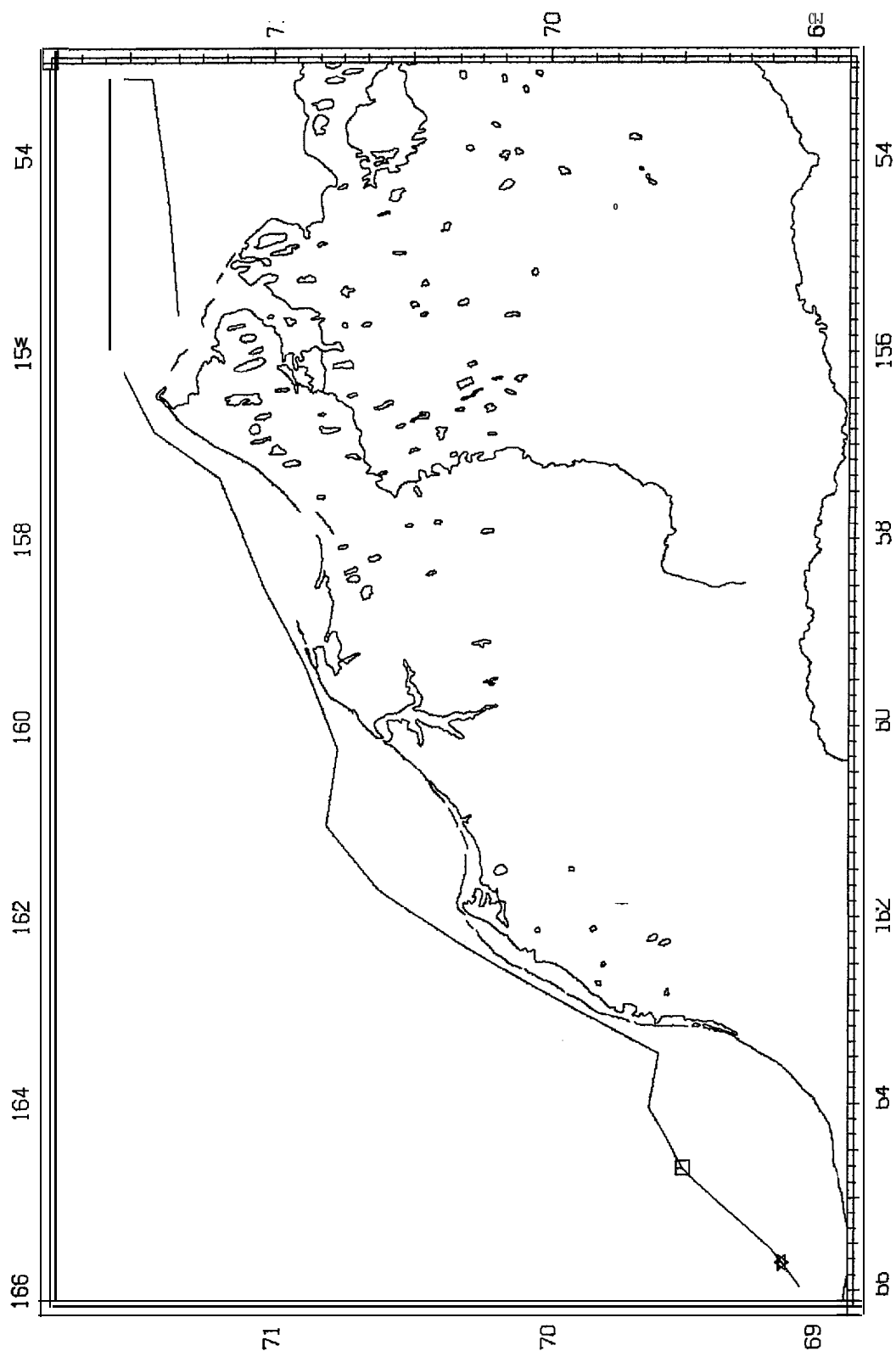
Flight was a coastal search survey from Pt. Barrow to Nome. The weather was mostly clear and windy. Visibility was generally unlimited. The shore fast leads from Pt. Barrow to Cape Lisburne were enlarging to over 10 km wide as a result of easterly winds. Sea state ranged from a Beaufort 01 to 07. Thirteen bowheads, **belukhas**, bearded **seals**, and a ringed seal were sighted along the coast in the **Chukchi** Sea.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH (M)
1/0	70°32.7'	162°13.9'		BO	Sw		9	1	20
1/0	70°29.2'	162°28.1'		BO	Sw	030	1	3	31
2/0	70°21.6'	162°45.2'		WD	Sw		1	3	9
2/0	70°18.7'	162°52.8'		BO	Sw		1	3	18
3/0	70°11.5'	163°07.3'		BO	MT		1	3	22
1/0	68°14.7'	166°52.9'		BO	Sw		7	1	15
1/0	66°16.8'	167°42.1'		BO	Sw	220	1	1	22
1/0	66°06.5'	167°55.2'		BO	Sw		1	1	18
1/0	65°35.3'	168°10.1'		BO	Sw		1	1	27

KEY FOR FLIGHT 3

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ★ (BEARDED SEAL)

Flight #13, 9 May, 1982



Flight #13, 9 May 1982

Flight was a coastal search survey from Cape Lisburne to Pt. Barrow. The weather was low ceiling. Visibility was generally less than 10 km. Ice coverage was 7/10 to 9/10 broken floe ice. Sea state ranged from a Beaufort 01 to 07. Five migrating bowheads, one belukha whale and a bearded seal were sighted near Pt. Barrow.

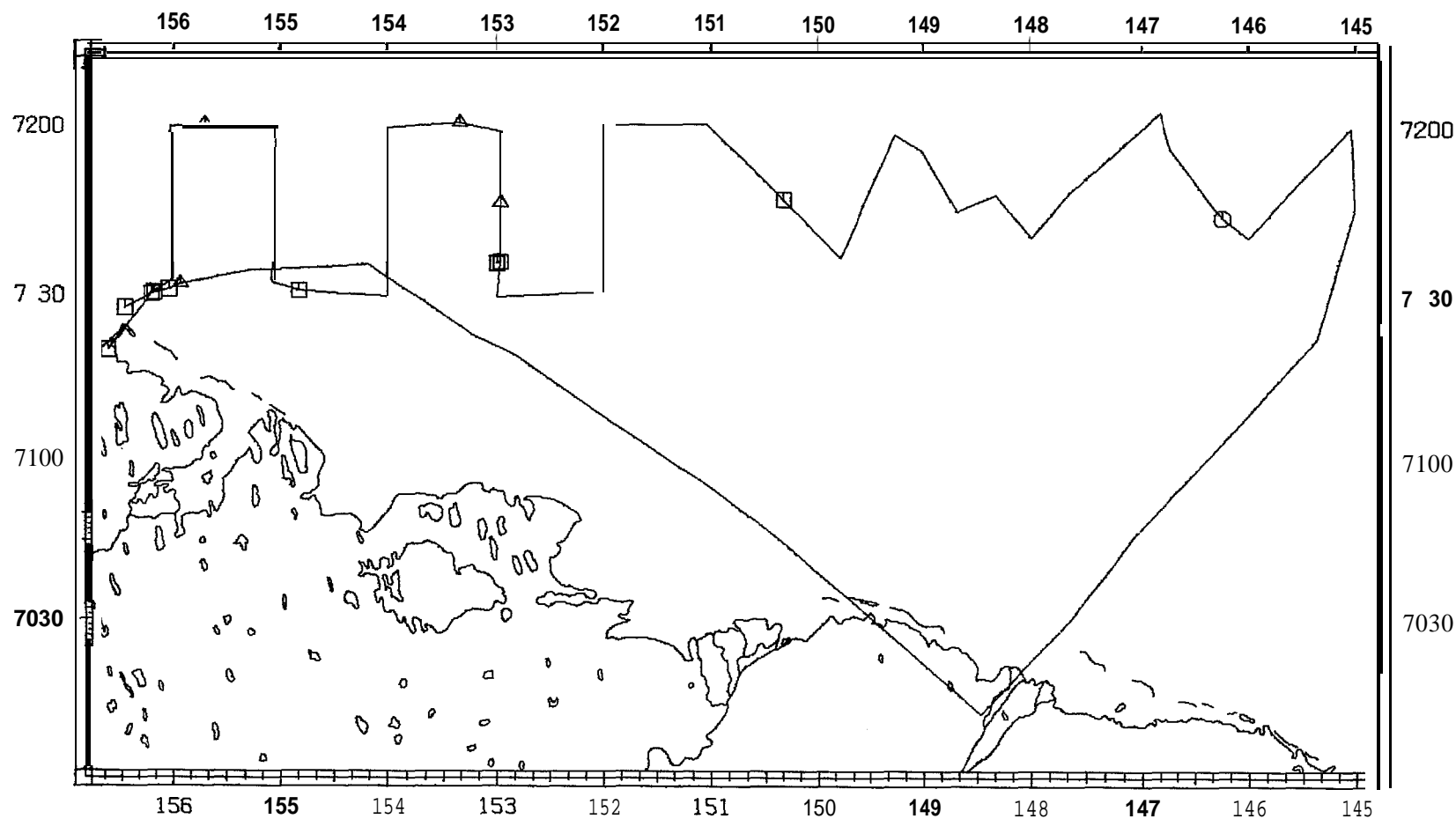
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HOG	ICE	SS	DEPTH(M)
2/0	69°30.0'	164°41.2'		BO	Sw	050	9	1	22
3/0	71°34.4'	153057.1 '		BO	SW	040	9	3	48

KEY FOR FLIGHT 14

- I (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- (NO SIGHTING)

Flight #14, 10 May, 1982

A-32



Flight #14, 10 May 1982

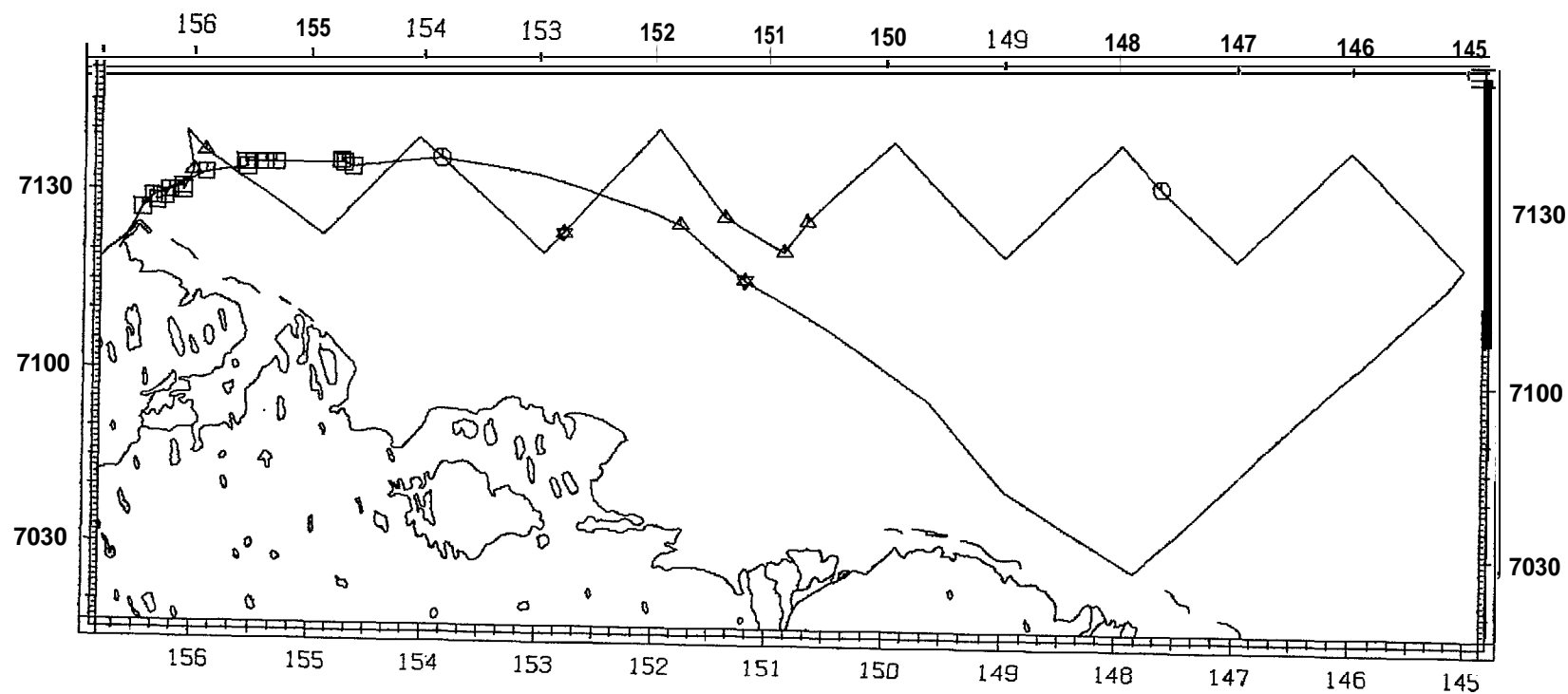
Flight was a systematic search survey between **71°30'N** and 72°N latitude west to 146° W longitude, with a refueling stop in Deadhorse before a return to Pt. Barrow. The weather was clear and windy. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 01 to 03. Twelve bowheads were sighted east of Pt. Barrow and their behaviors were recorded. **Belukhas** were also sighted.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HOG	ICE	Ss	DEPTH (M)
3/0	71°20.0'	156°38.0'		SP	DI	020	1	2	7
2/0	71°30.2'	156°12.3'		BO	Sw	040	9	3	51
1/0	71031.0'	156°02.6'		BO	Sw		9	3	18
1/0	71047.1 '	150°19.5'		WD	Sw		9	1	2379
1/0	71035.9'	152°58.0'		BO	Sw		9	1	73
1/0	71°35.6'	152°59.8'		BO	Sw		9	1	73
1/0	71°30.8'	154°49.8'		BO	Sw		9	1	110
1/0	71030.4'	156°10.9'		BO	Sw		1	3	33
1/0	71°27.7'	156°28.0'		BO	Sw		1	3	9

KEY FOR FLIGHT 15

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✱ (BEARDED SEAL)
- (NO SIGHTING)

Flight #15, 12 May, 1982



Flight #15, 12 May 1982

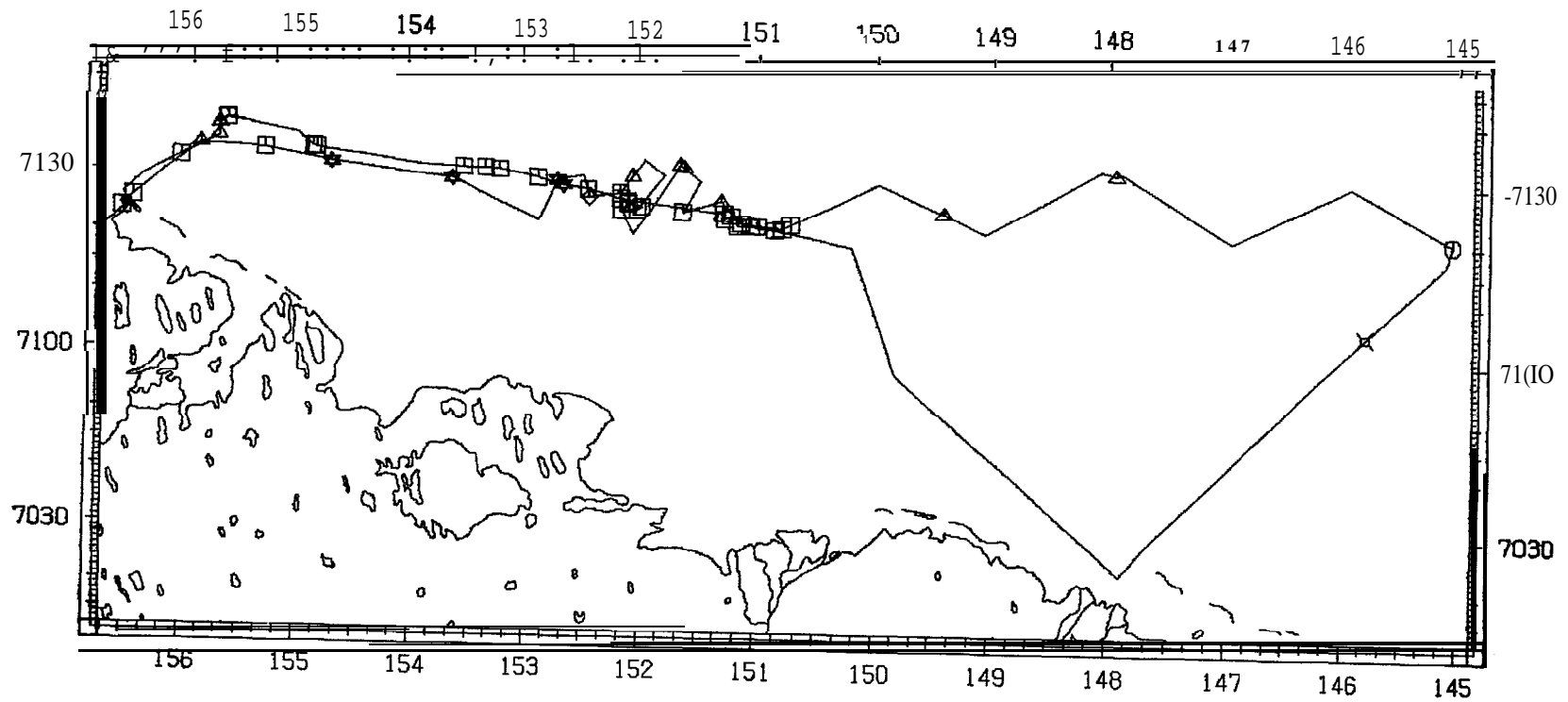
Flight was a systematic search survey between 71°20'N and 71 °40'N latitude west to 145° N longitude. The weather was overcast. Visibility was generally less than 10 km. Ice coverage was 9/10 to 10/10 floe **ice**. Sea state was Beaufort 01 to 02. Thirty-six bowheads and three bowhead ice tracks were seen. Belukhas and bearded seals were sighted northeast of Pt. Barrow.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
2/0	71°26.9'	156°26.4'		BO	Sw	040	1	2	9
6/0	71°28.9'	156°20.8'		BO	Sw		1	2	18
2/0	71°33.0'	155°53.7'		BO	Sw		1	2	24
4/0	71°33.9'	155°32.8'		BO	Sw		1	2	159
3/0	71°34.8'	155°33.4'		BO	Sw		1	2	163
2/0	71°34.8'	155°23.9'		BO	SW		1	2	110
1/0	71°34.8'	155°18.3'		BO	Sw		1	2	57
1/0	71°34.9'	154°42.3'		BO	Sw		1	2	44
2/0	71°35.2'	154°44.0'		BO	Sw		1	2	42
2/0	71°34.3'	154°37.9'		BO	Sw		1	2	36
2/0	71°29.9'	156°05.2'		BO	Sw		1	2	12
2/0	71°30.6'	156°05.1'		BO	Sw		7	1	18
2/0	71°30.0'	156°12.3'		BO	Sw		7	1	19
3/0	71°28.8'	156°14.6'		BO	DI	040	1	2	15
2/0	71°28.1'	156°18.8'		BO	DI		1	2	18

KEY FOR FLIGHT 16

- (BOWHERD WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ◆ (BEARDED SEAL)
- ◇ (WALRUS)
- (NO SIGHTING)

Flight #16, 13 May, 1982



Flight #16, 13 May 1982

Flight was a systematic search survey between from 71°20'N and 71°30'N latitude from 145°W to 156°W longitude. The weather was overcast. Visibility was generally less than 10 km. ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 01. Sixty bowheads, including a cow-calf pair and a cow-yearling pair, were sighted east of Pt. Barrow. Most whales appeared to be actively migrating. Sounds via sonobuoys were recorded. Belukhas, bearded seals, ringed seals and walrus were also sighted.

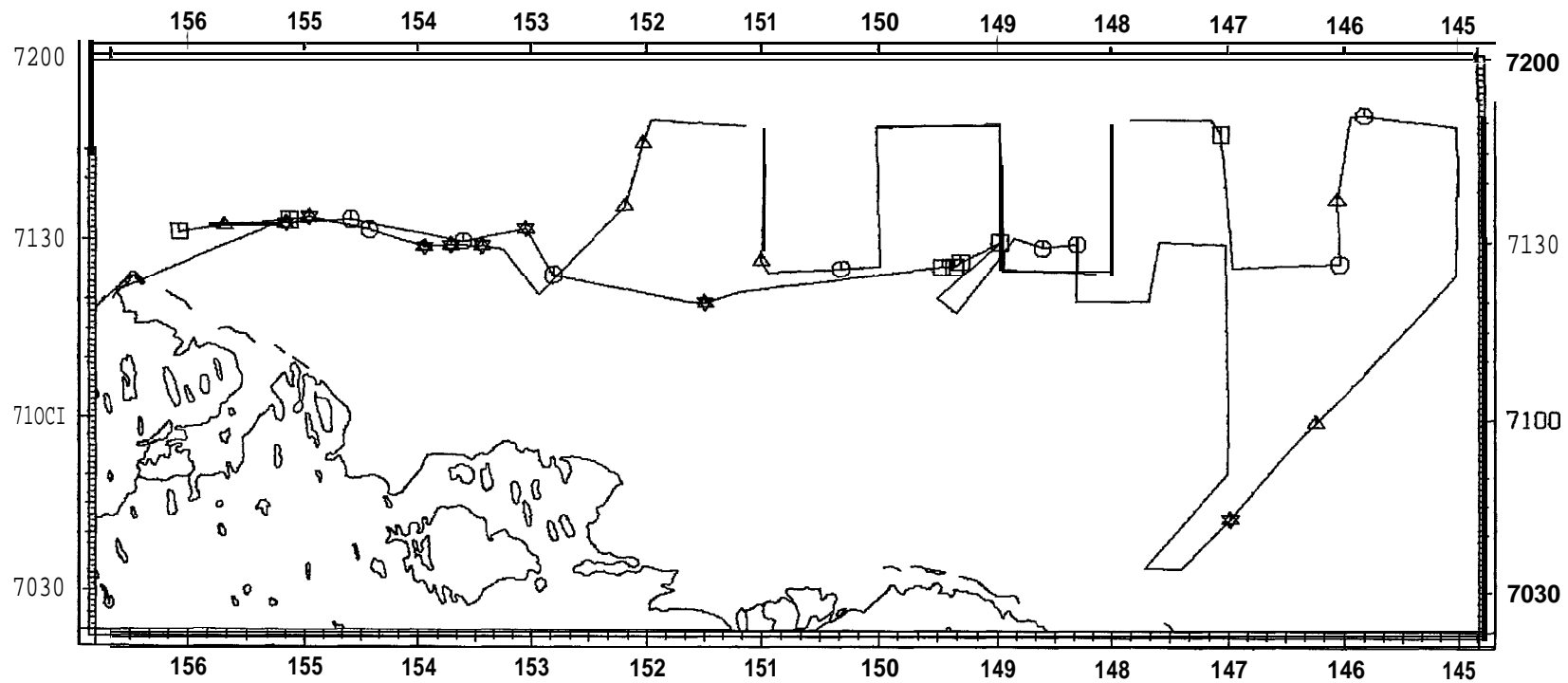
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
2/0	71°32.3'	156°00.3'		BO	Sw	060	8	1	36
1/0	71°38.5'	155°36.1'		WD	Sw	060	8	1	238
1/0	71°34.0'	154°51.8'		BO	FE	180	8	1	44
3/0	71°33.9'	154°50.3'		BO	GM	060	8	1	44
1/0	71°31.0'	153°33.6'		BO	Sw	040	9	1	49
2/0	71°30.9'	153°22.1'		BO	Sw	050	9	1	49
1/0	71°30.7'	153°14.5'		BO	Sw	050	9	1	47
2/0	71°29.4'	152°54.5'		BO	Sw	050	9	1	177
2/0	71°27.6'	152°28.1'		BO	Sw	030	9	1	164
1/0	71°26.2'	152°11.0'		WD	Sw	060	9	1	183
3/0	71°24.0'	151°17.4'		BO	GM	090	9	1	475
1/0	71°23.1'	151°16.7'		BO	MT		9	1	475
5/0	71°23.6'	151°13.7'		BO	Sw		9	1	475
3/0	71°22.3'	151°08.4'		BO	Sw	050	9	1	458
2/0	71°21.9'	151°03.2'		BO	Sw	040	9	1	458
1/0	71°21.3'	150°51.1'		BO	Sw		9	1	1025
1/0	71°22.3'	150°43.8'		BO	Sw	060	9	1	1025
2/0	71°21.6'	150°48.0'		BO	RE		9	1	1025
2/0	71°22.0'	151°00.0'		BO	Sw	060	9	1	594
1/0	71°21.9'	151°10.0'		BO	Sw	060	9	1	457
1/0	71°24.1'	151°38.8'		BO	DI	050	9	1	329
5/0	71°24.4'	152°10.6'		BO	GS	060	9	1	87
2/0	71°25.4'	152°07.3'		BO	Sw	060	9	1	220
4/0	71°25.7'	152°07.4'		BO	Sw	060	9	1	55
1/0	71°24.9'	152°00.3'		BO	Sw	060	9	1	73
3/0	71°24.4'	152°02.4'		BO	Sw	060	9	1	73
3/0	71°27.1'	152°11.3'		BO	Sw	060	9	1	73
2/1	71°33.7'	155°16.9'		BO	Sw	060	9	1	20
1/0	71°25.4'	156°25.9'		BO	Sw		9	1	9
1/0	71°23.7'	156°31.6'		BO	Sw		9	1	6

KEY FOR FLIGHT 17

- I (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ★ (BEARDED SEAL)
- ⊙ (NC! SIGHTING)

Flight #17, 14 May, 1982

A-38



Flight #1 7, 14 May 1982

Flight was a systematic search survey of the western Beaufort Sea roughly from 71°20'N to 71°50'N latitude between 152°W and 145°W longitude. The weather was overcast. Visibility was generally less than 10 km. Ice coverage as 9/10 to 10/10 broken floe ice. Sea state was Beaufort 00 to 01. Nine bowheads were sighted east of Pt. Barrow. Their behaviors were recorded on video and sounds were recorded via sonobuoy. Bowhead ice tracks, belukhas and bearded seals were also sighted.

T#/C#	LAT(N)	LONG(W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
2/0	71°25.6'	149°27.8'		BO	DI	060	9	1	1830
1/0	71°25.7'	149°21.4'		BO	SW	060	9	1	1830
1/0	71°26.5'	149°18.3'		BO	Sw	010	9	1	1830
2/0	71°29.7'	148°59.1'		BO	SW	060	9	1	1830
1/0	71°47.8'	147°03.5'		WD	Sw		9	1	3202
1/0	71°33.2'	155°07.4'		WD	Sw		9	1	20
1/0	71°31.3'	156°04.1'		BO	SW	040	9	1	18

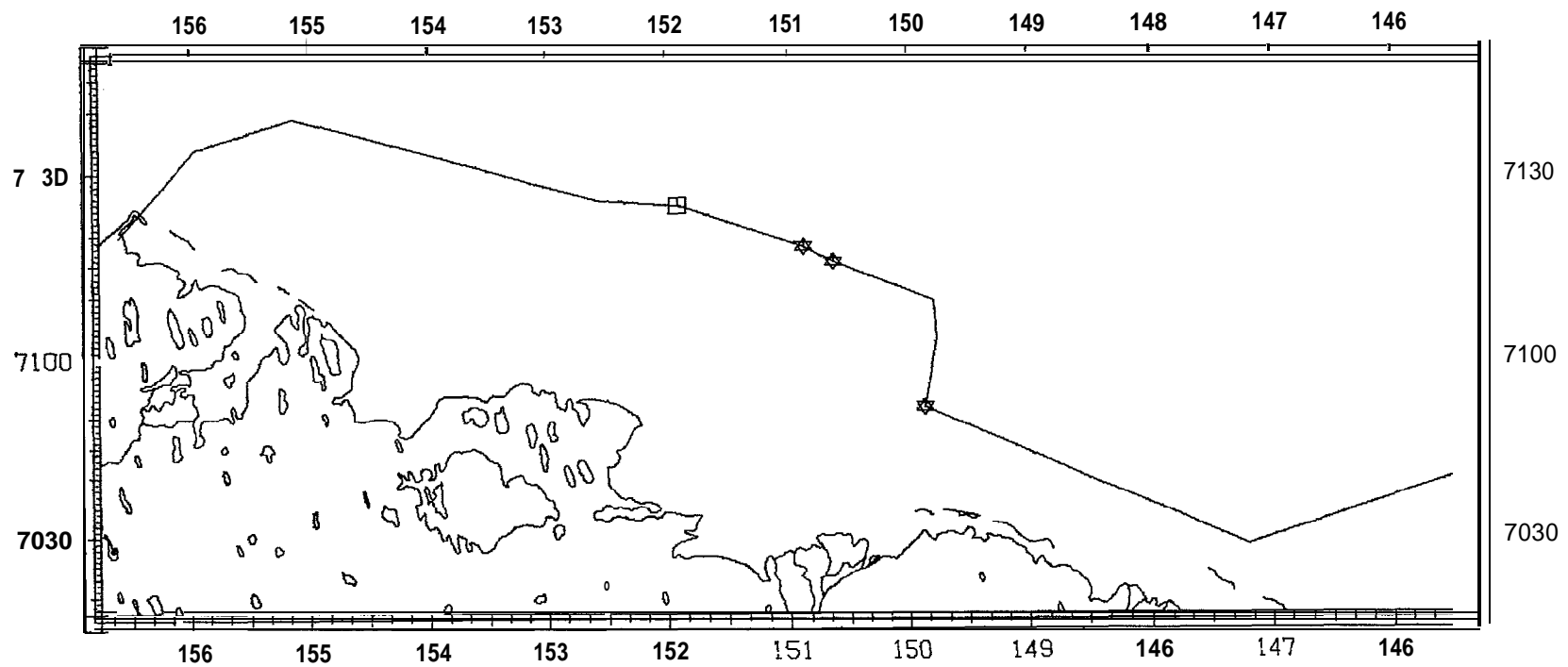
Flight #18, 19 May, 1982

KEY FOR FLIGHT 18

★ (BEARDED SEAL)

□ [NC! SIGHTING]

A-40



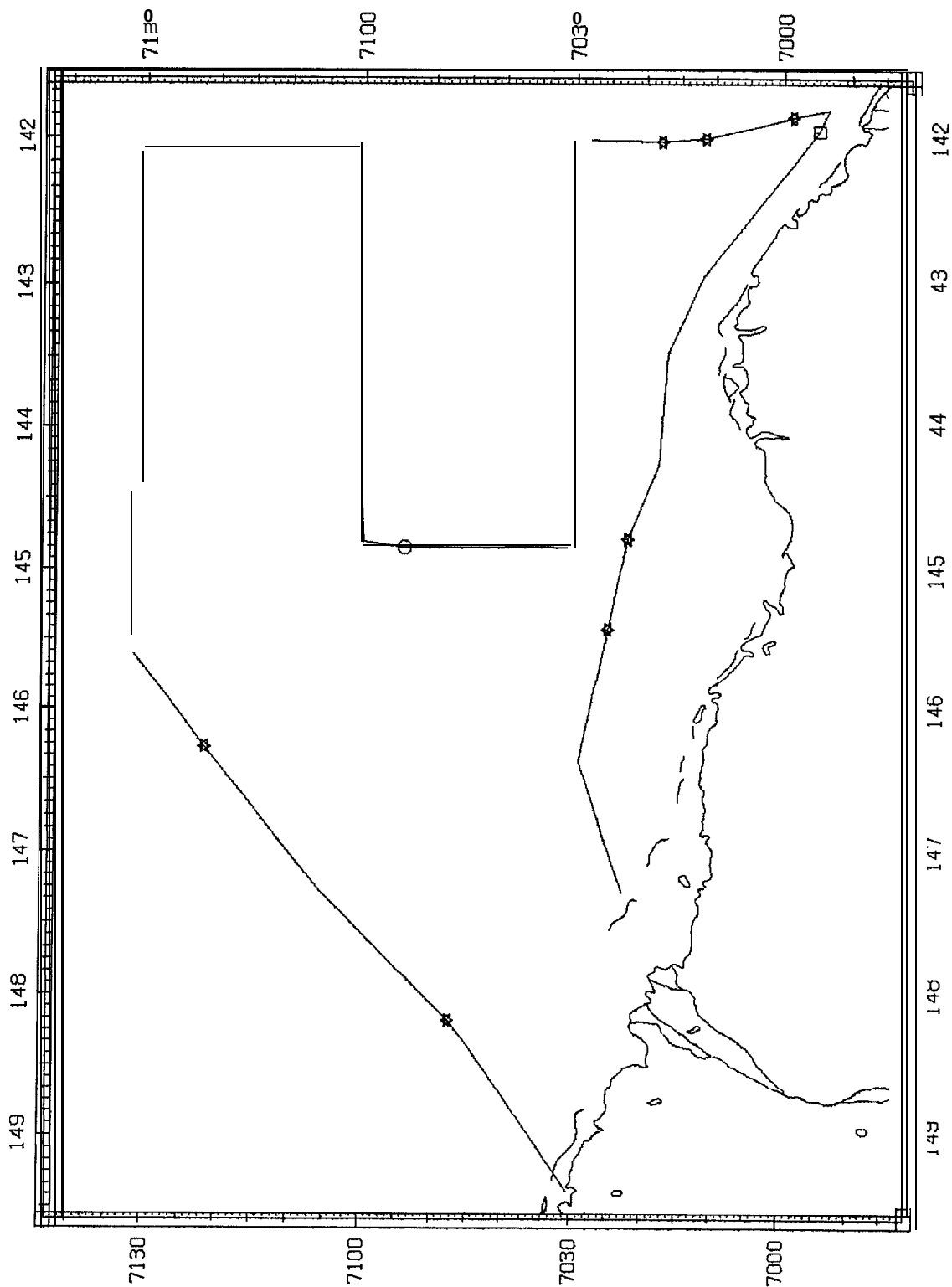
Flight #18, 19 May 1982

Flight was a transit from Pt. Barrow to Oliktok. The weather was low ceiling and fog. Visibility was generally less than 10 km. Ice coverage was 9/10 to 10/10 broken floe ice. Sea state was Beaufort 01. Only bearded seals were sighted.

KEY FOR FLIGHT 19

- ✕ (RINGED SEAL)
- ★ (BEARDED SEAL)
- (POLAR BEAR)
- (NO SIGHTING)

Flight #19, 21 May, 1982



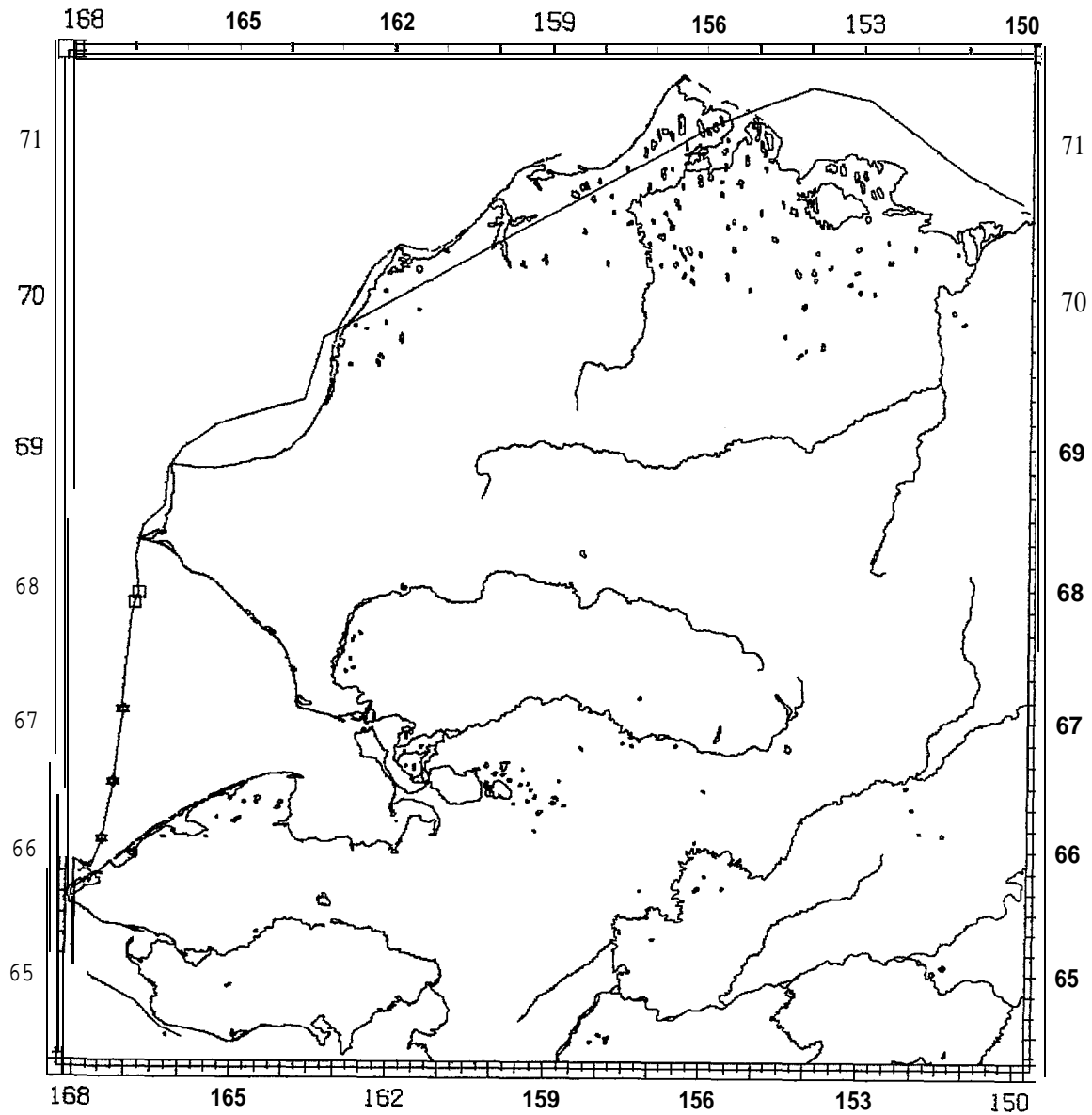
Flight #19, 21 May 1982

Flight was a systematic search survey northeast of Deadhorse to assess the ice coverage and search for bowhead whales. The weather was cloudy. Visibility was generally over 10 km. Ice coverage was 9/10 to 10/10 broken floe ice, except for a shore fast lead near Barter Island. Sea state was Beaufort 00 to **02**. **No** bowheads were sighted. Bearded seals, ringed seals and a polar bear were seen. Two **sonobuoys** were dropped but no bowhead sounds were recorded.

KEY FOR FLIGHT 20

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ⊛ (BEARDED SEAL)
- ◇ (WALRUS)

Flight #20, 22 May, 1982



Flight #20, 22 May 1982

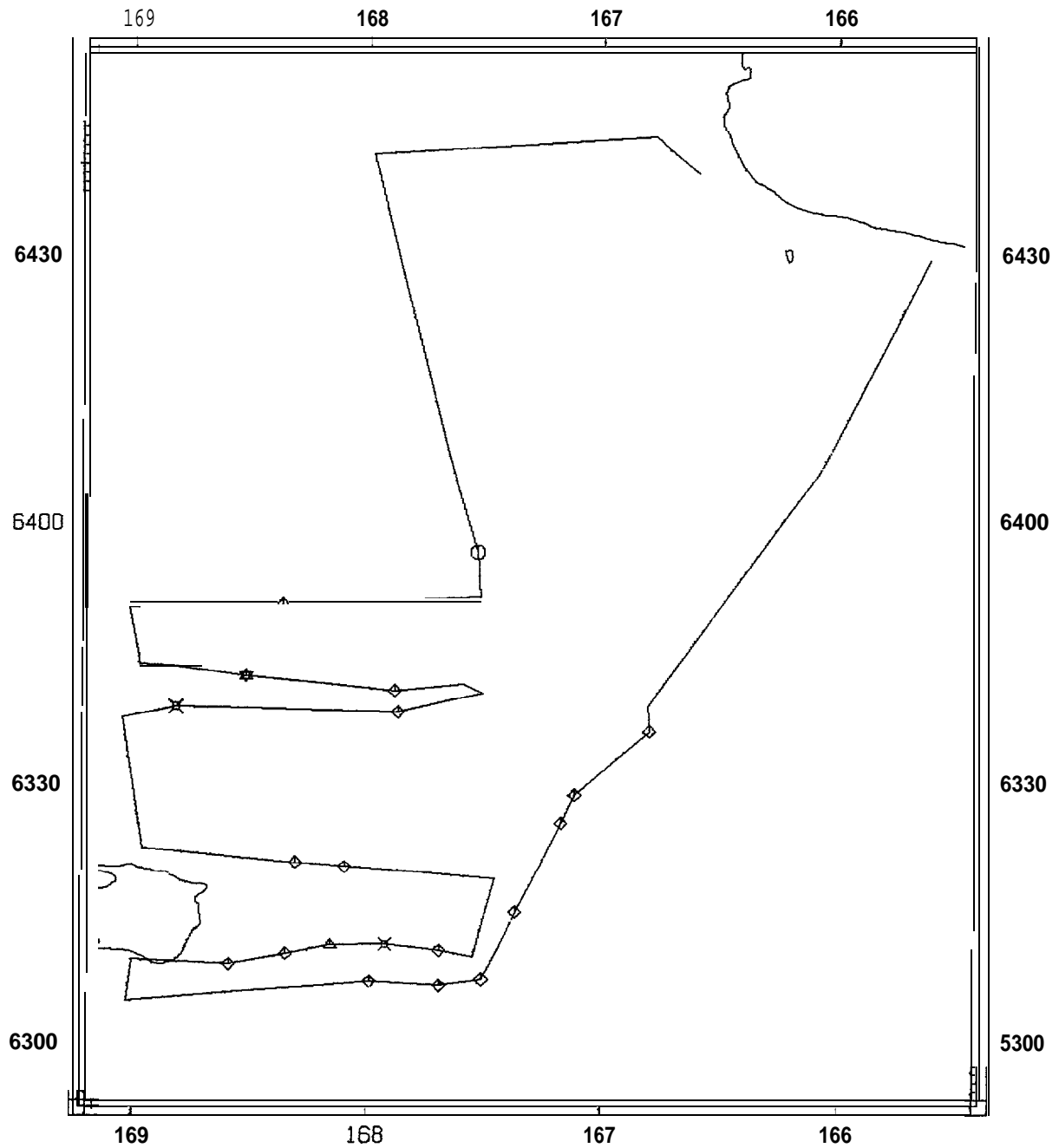
Flight was a coastal search survey from Wainwright to Nome. The weather was overcast. Visibility was generally over 10 km. Many fields of broken floe ice remained in the Chukchi Sea west of the shore fast ice. Ice coverage was 7/10 to 10/10. Sea state was Beaufort 02 to 04. Three bowheads, including a cow-calf pair, belukhas, bearded seals, ringed seals and walrus were sighted in the Chukchi Sea.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HOG	ICE	SS	DEPTH(M)
2/1	67°57.8'	166°48.5'		BO	RE	330	1	0	55
1/0	67°53.6'	166053.1 '		WD	Sw	330	1	0	57

KEY FOR FLIGHT 21

- (GRAY WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ☆ (BEARDED SEAL)
- ◇ (WALRUS)

Flight #21, 23 May, 1982



Flight #21 , 23 May 1982

Flight was a transect survey of block C near St. Lawrence Island. The weather was clear or partly cloudy. Visibility was generally unlimited. some shore fast ice was present along St. Lawrence Island, and there were fields of broken flow ice to 9/10 coverage. Sea state was Beaufort 02 to 03. No bowheads were seen. Two gray whales, belukhas, bearded seals, ringed seals and walrus were sighted near St. Lawrence Island.

▲ (BELUGA WHALE)
 ☆ (BEARDED SEAL)
 ◆ (WALRUS)

▲ (BELUGA WHALE)
 ☆ (BEARDED SEAL)
 ◆ (WALRUS)



Flight #22, 24 May 1982

Flight was a transect survey of block A, Norton Sound. The weather was overcast. Visibility was generally over 10 km. Ice coverage was 8/10 to 9/10 broken floe ice. Sea state was Beaufort 02 to 03. Run off from the Yukon River muddied the water **at** the southern end of our transect legs. No bowheads were sighted. **Belukhas**, bearded seals and walrus were sighted.

▲ (BELUGA WHALE)
 X [RINGED SEAL]
 ☆ [13 EARED SEAL]
 ◆ (WALRUS)

Flight #23, 25 May 1982

Flight was a search survey between St. Lawrence Island and King Island. The weather was overcast. Visibility was generally over 10 km. Ice coverage was 6/10 to 7/10 broken floe ice. Sea state was Beaufort 02 to 04. No bow-heads were sighted. An estimated 50 belukhas, most with calves, yearlings or juveniles, were seen south-east of King Island. Bearded seals, ringed seals and walrus were also sighted.

Flight #24, 10 July, 1982

• I (NO) SIGHTING

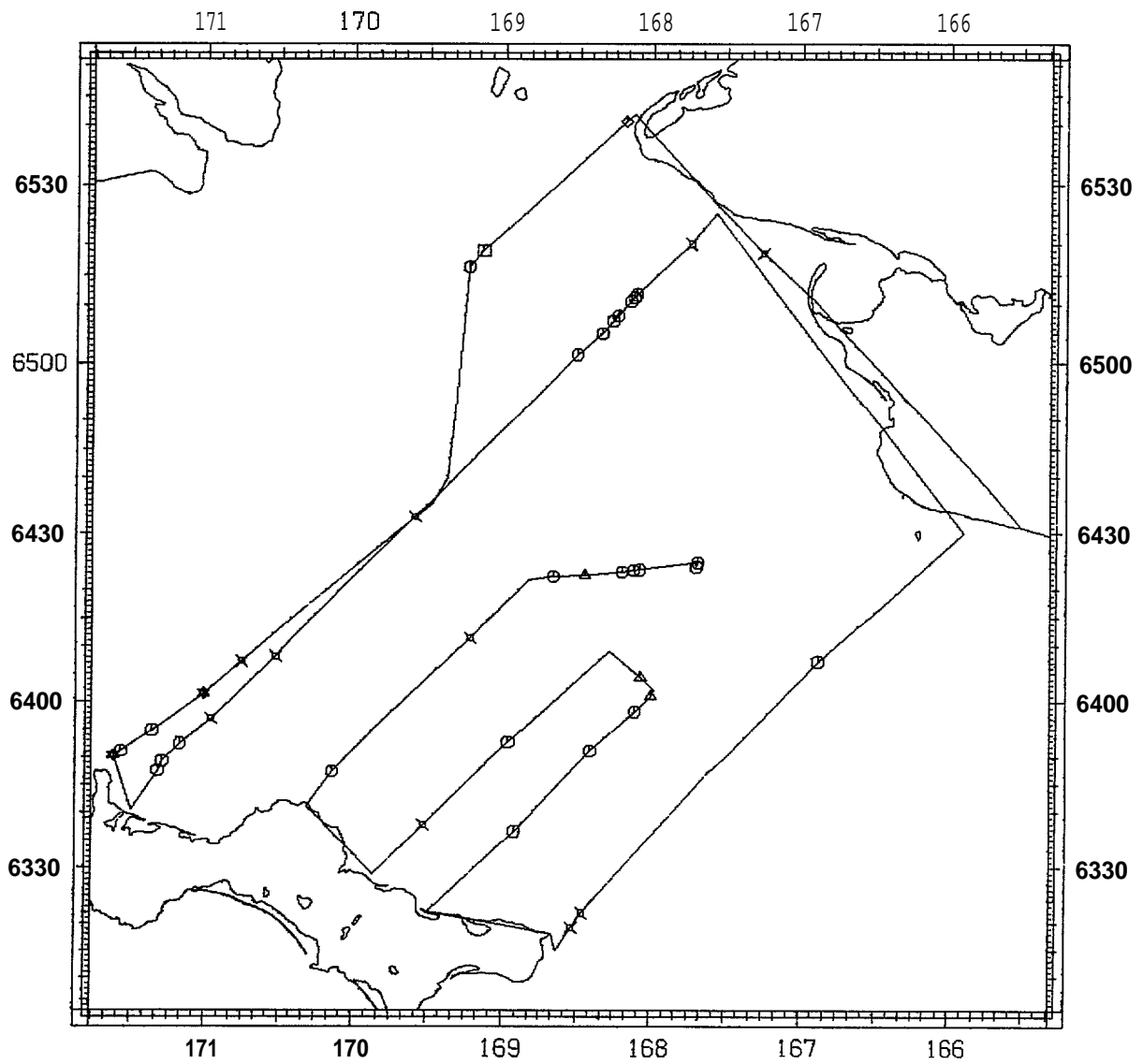
Flight #24, 10 July 1982

Flight was a line transect survey northeast of St. Lawrence Island in support of LGL. Weather was low overcast and fog with visibility ranging from unlimited to less than 1 km. Sea state was Beaufort 01 to 03. Seventeen gray whales and one unidentified pinniped were sighted near St. Lawrence Island.

KEY FOR FLIGHT 25

- CI (GRAY WHALE)
- (MINKE WHALE)
- ✱ (BEARDED SEAL)
- △ (NO SIGHTING)
- ✕ [UNKNOWN PINNIPED]
- ◇ (DEAD WALRUS)

Flight #25, 11 July, 1982



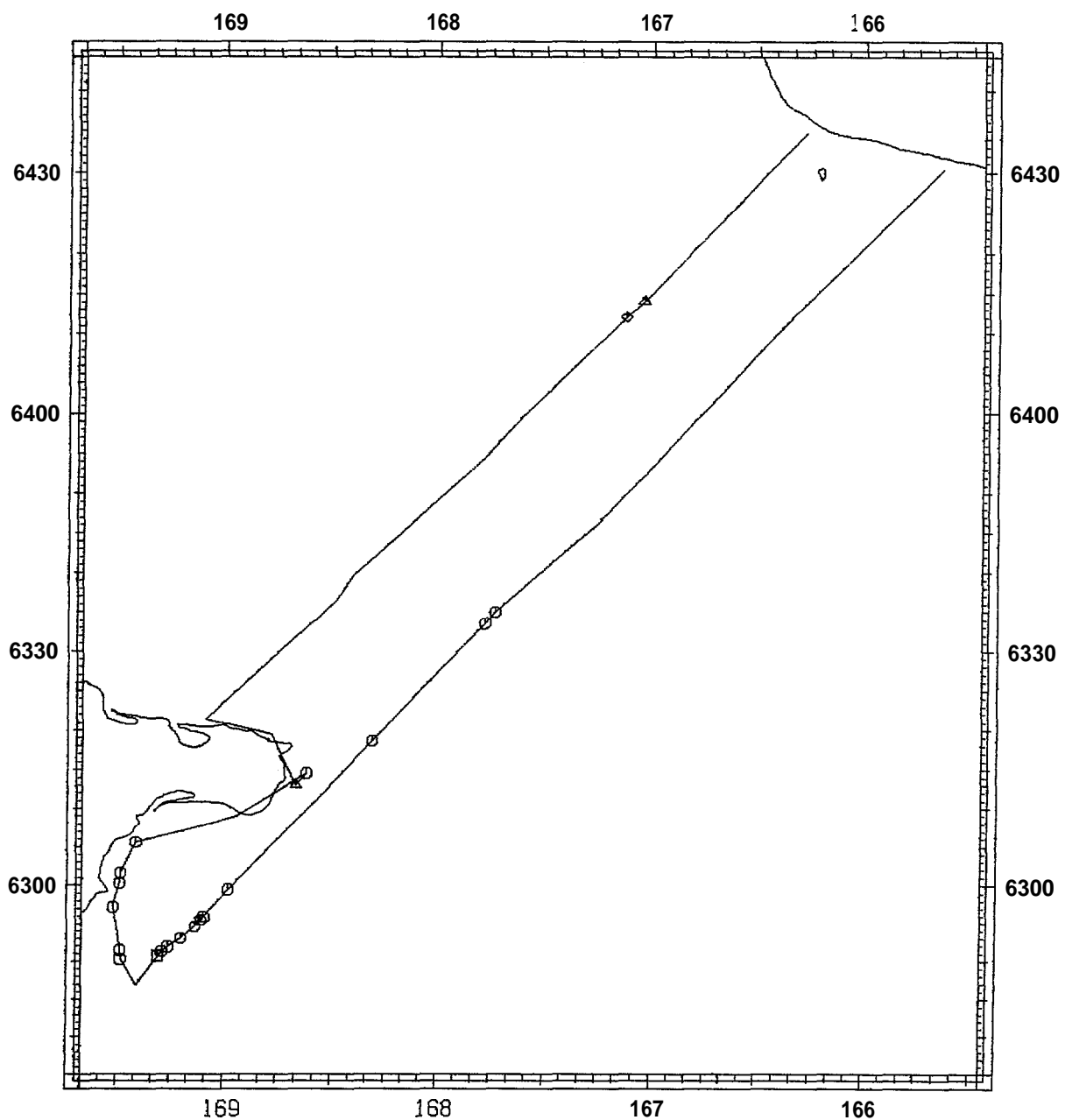
Flight #25, 11 July 1982

Flight was a line transect survey between St. Lawrence Island and Seward Peninsula in support of LGL. Weather was partly **cloudy** with areas of patchy fog. Visibility was unlimited over most of the survey track with areas of 1-2 km limitation. Sea state ranged from Beaufort 01 to 02. Thirty-nine gray whales, one minke whale, bearded seals, and unidentified **pinnipeds** were sighted near St. Lawrence Island. One gray whale carcass was sighted and photographed.

KEY FOR FLIGHT 26

- (GRAY WHALE)
- ◇ (WALRUS)
- [NO SIGHTING]
- △ (UNKNOWN PINNIPED)

Flight #26, 12 July, 1982



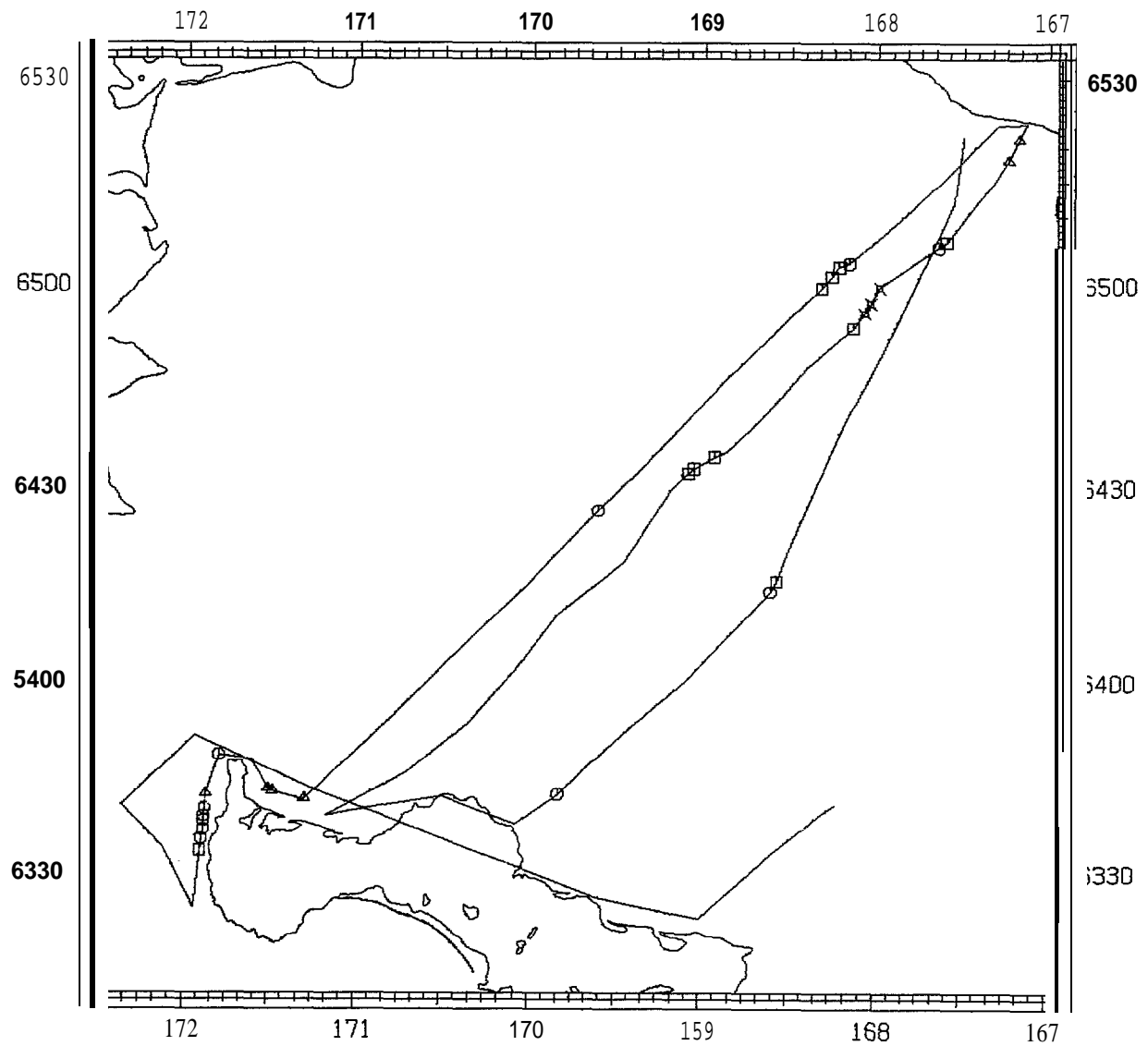
Flight #26, 12 July 1982

Flight was a line transect **survey** between Nome and Southeast Cape, St. Lawrence Island **in** support **of** LGL. Weather ranged from clear to heavy fog; visibility from unlimited to unacceptable. Sea state was Beaufort 01 to 02. Twenty-eight gray whales and several unidentified pinnipeds were sighted. one gray whale carcass with extensive wounds along its lower jaw was seen and photographed off the north shore of St. Lawrence Island. One walrus carcass was also sighted.

KEY FOR FLIGHT 27

Flight #27, 17 July, 1982

- (GRAY WHALE)
- (NO SIGHTING)
- △ (UNKNOWN PINNIPED)
- ✕ (DEAD WALRUS)



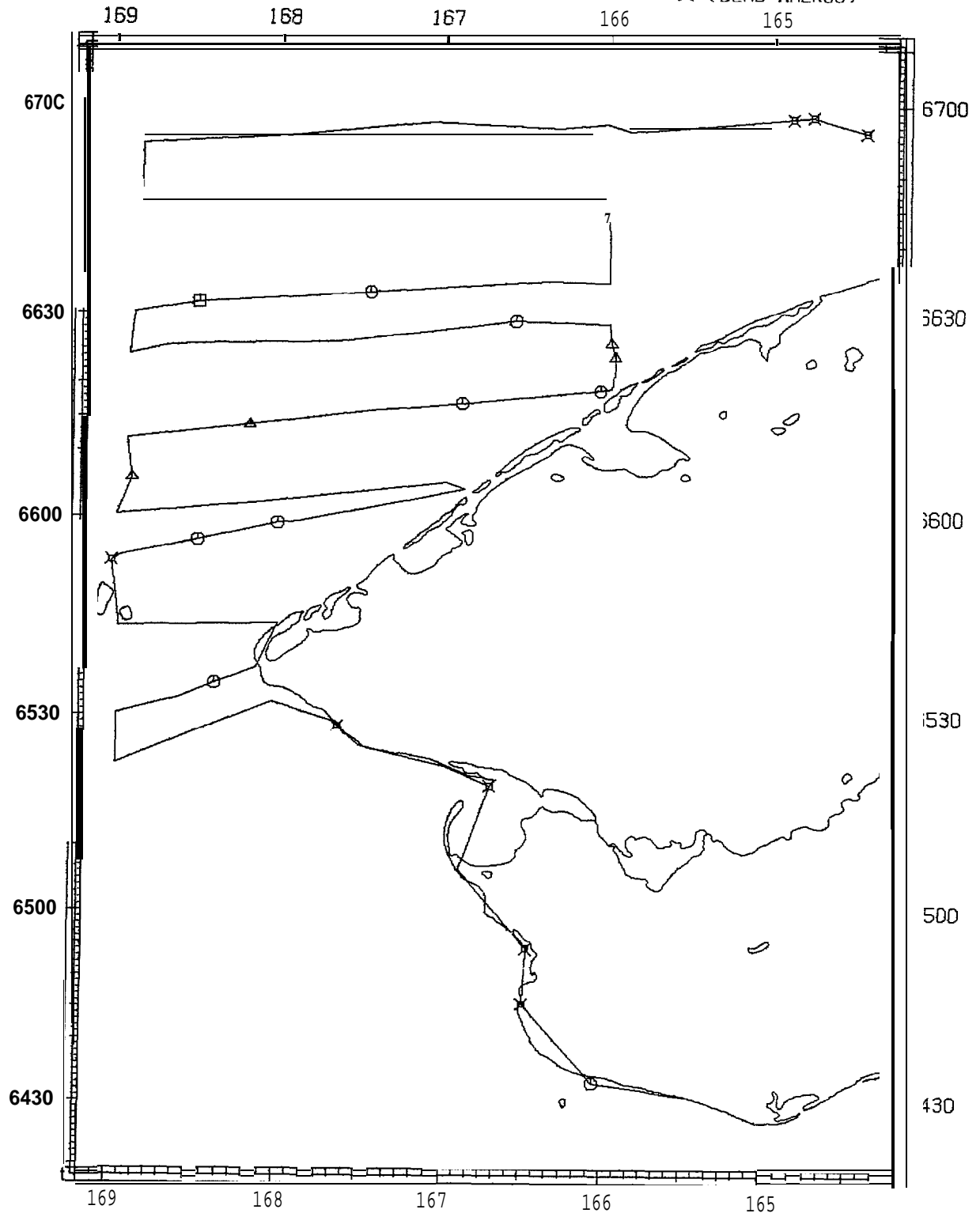
Flight #27, 17 July 1982

Flight was a line transect survey between St. Lawrence Island and the Seward Peninsula in support of LGL. Weather was partly cloudy with some patchy fog; visibility ranged from unlimited to unacceptable. Sea state ranged from **Beaufort** 01 to 03. Seventeen gray whales, floating walrus carcasses and unidentified **pinnipeds** were sighted near St. Lawrence Island.

KEY FOR FLIGHT 28

Flight #28, 18 July, 1982

- (GRAY WHALE)
- (NO SIGHTING I
- △ (UNKNOWN PINNIPED)
- ✕ (DEAD WALRUS)



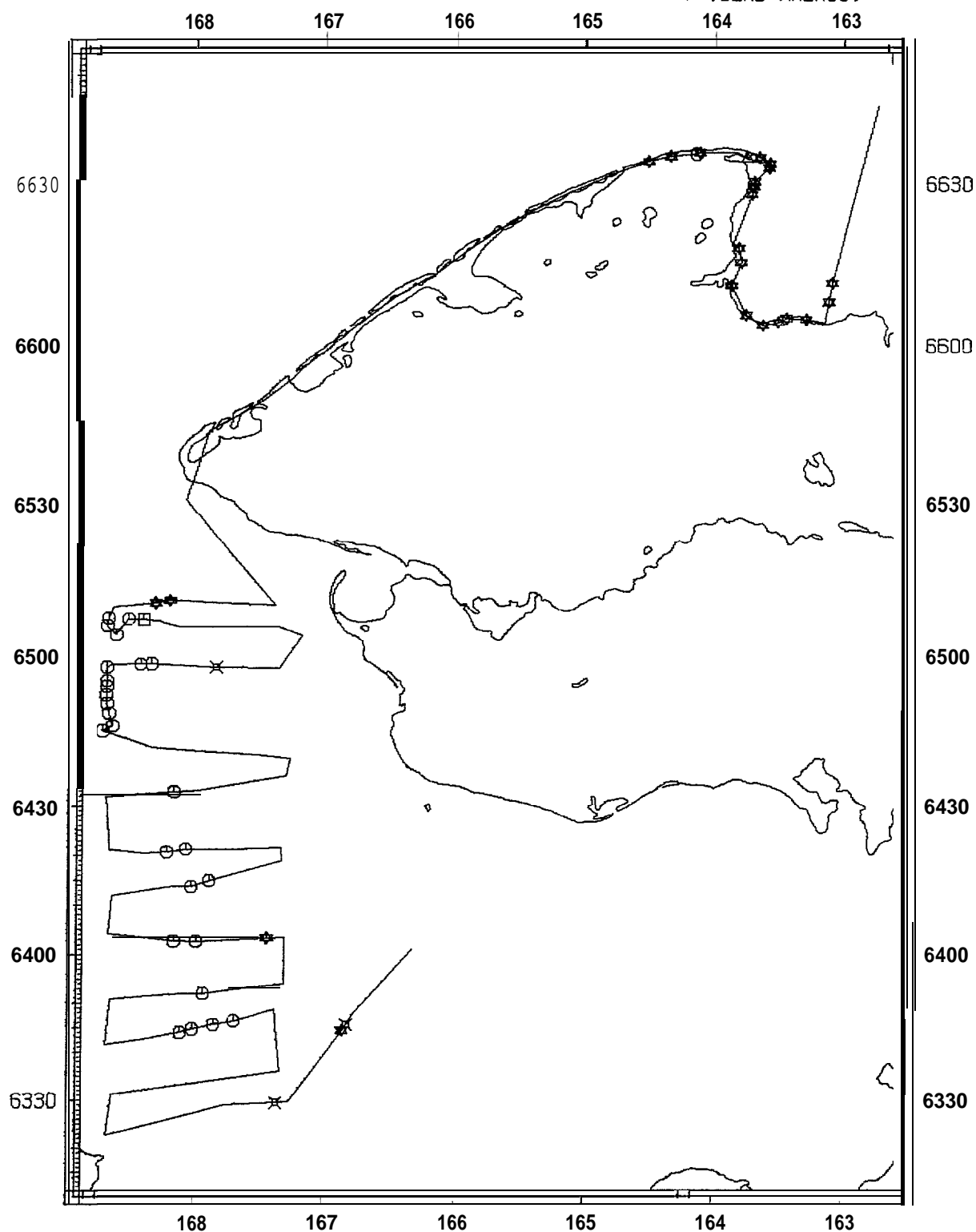
Flight #28, 18 July 1982

Flight was a coastal survey of the southern Seward Peninsula and a line transect survey in blocks G and H. Weather was variable ranging from clear to patchy fog and haze. Visibility ranged from unlimited to less than 1 km. Sea state ranged from Beaufort **02 to 03**. Nine gray whales, including one calf, were sighted north of the Bering Strait. Many headless walrus carcasses were counted along the beach.

Flight #29, 19 July, 1982

KEY FOR FLIGHT 29

- (GRAY WHALE)
- △ (BELUGA WHALE)
- (NO SIGHTING)
- ✕ (UNKNOWN PINNIPED)
- ☆ (DEAD WALRUS)



Flight #29, 19 July 1982

Flight was a coastal survey of the northern Seward Peninsula and a line transect survey in block C. Weather was clear. Visibility was unlimited. Sea state ranged from Beaufort 01 to 02. Fifty-five gray whales and four unidentified pinnipeds were sighted. Two gray whales and one belukha whale carcass, as well as over one hundred headless walrus carcasses were sighted along the beach in the northern Bering and southern Chukchi sea.

① (GRAY WHALE)
A (BELUGA WHALE)
•I (NO SIGHTING)

The map displays the study area in the western Pacific Ocean, bounded by latitudes 6300 to 6500 and longitudes 166 to 169. The Philippines and Taiwan are shown in the upper right. A series of sampling stations are marked with circles and squares, connected by lines, indicating a survey track. A diagonal line is also drawn across the map.

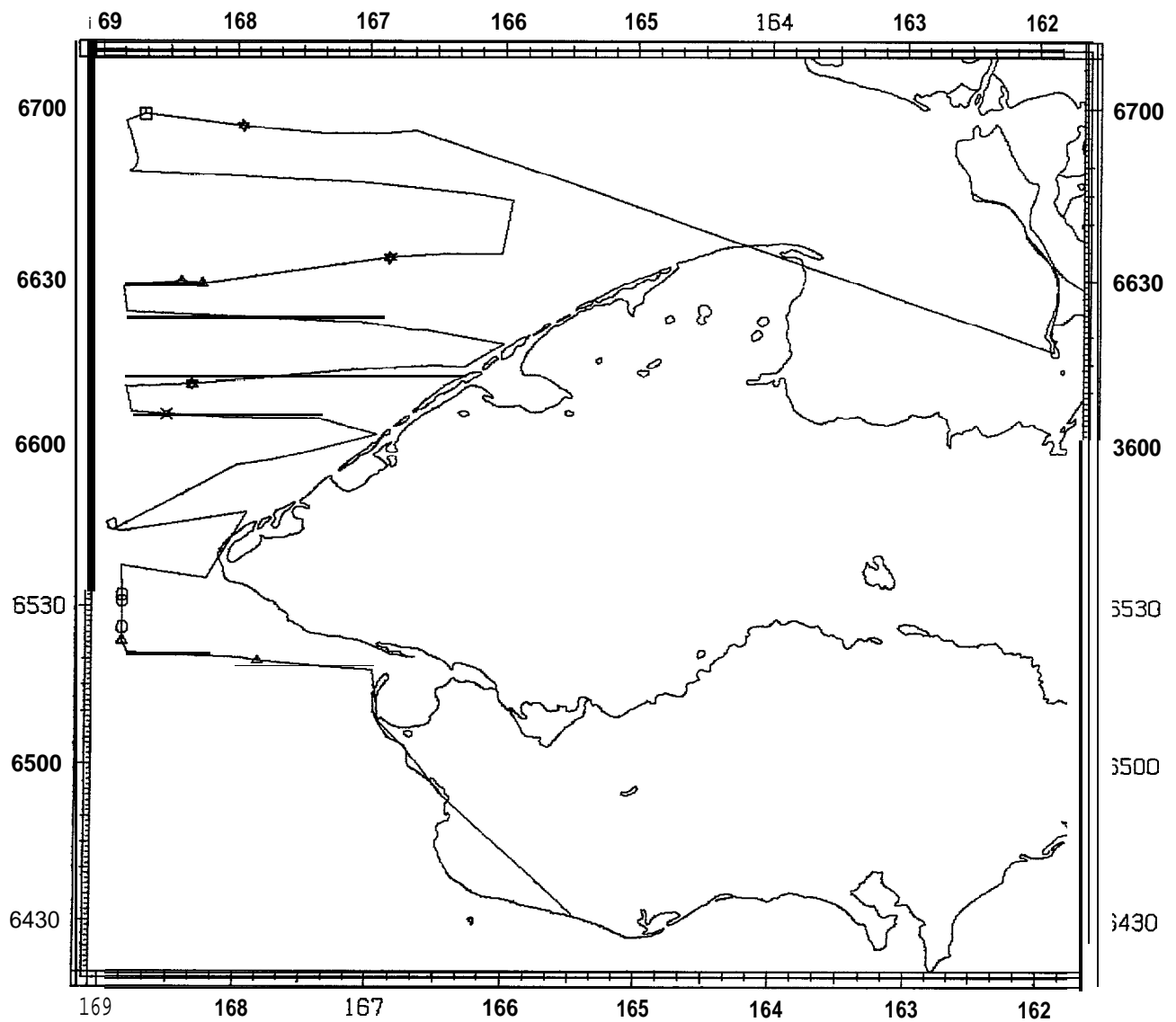
Flight #30, 24 July 1982

Flight was a line transect survey of block C and a search survey around Southeast Cape at St. Lawrence Island. Weather was clear to partly cloudy; visibility was unlimited with occasional haze. Sea state ranged from Beaufort 01 to 03. Forty-two gray whales, belukha whales and an unidentified pinniped were sighted in the northern Bering Sea. One sonobuoy was dropped but no sounds recorded.

KEY FOR FLIGHT 31

- (GRAY WHALE)
- (UNKNOWN CETACEAN)
- △ (NO SIGHTING)
- ✕ (UNKNOWN PINNIPED)
- ★ (DEAD WALRUS)

Flight #31, 30 July, 1982



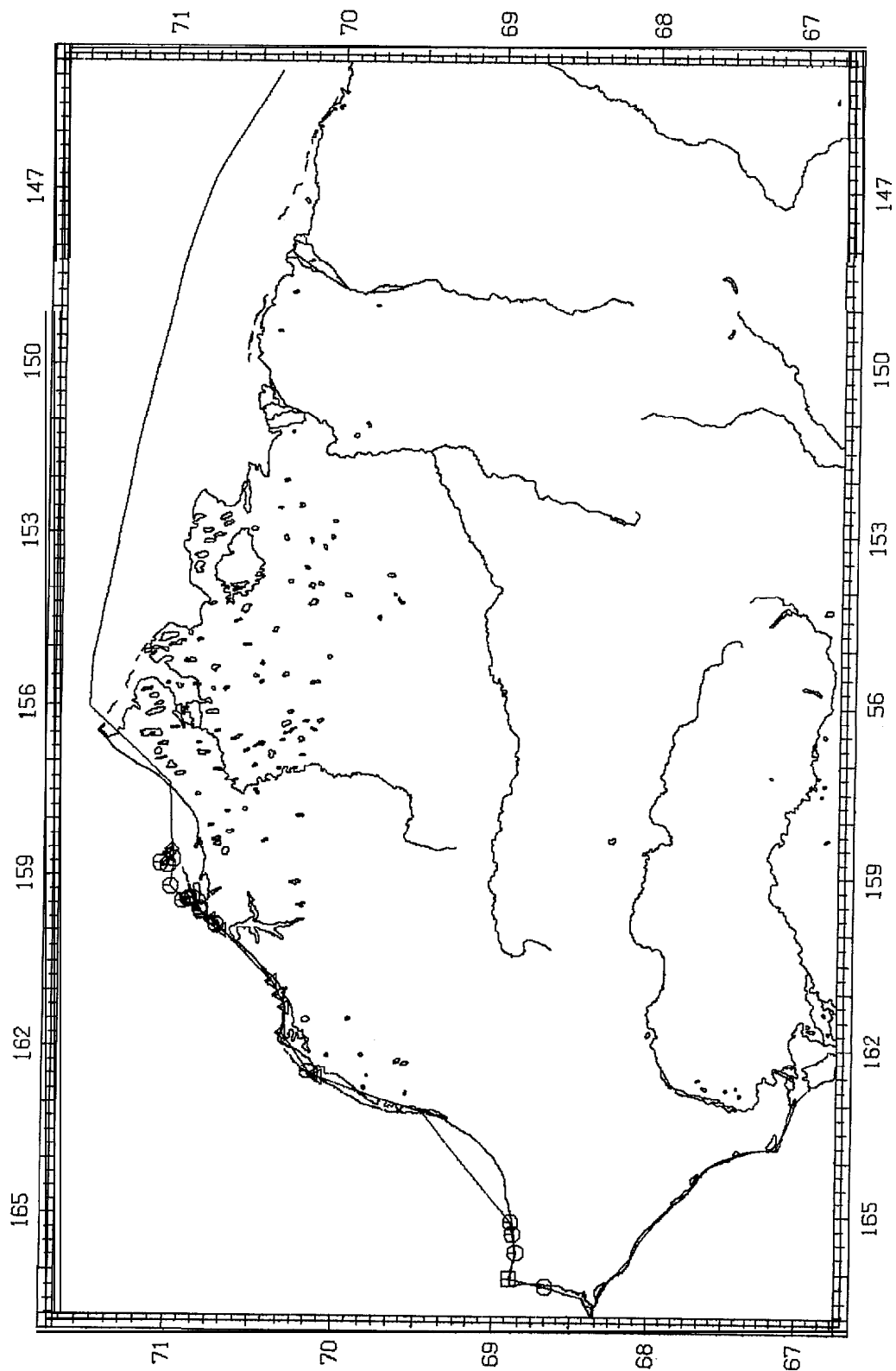
Flight #31, 30 July 1981

Flight was a line transect survey of blocks G and H and a coastal search survey of the Baldwin Peninsula. Weather ranged from clear to areas of heavy fog. Visibility ranged from unlimited to unacceptable. Sea state ranged from Beaufort 01 to 05. Three gray whales, one unidentified pinniped and one unidentified cetacean were sighted north of the Bering Strait. Many headless walrus carcasses were seen along Baldwin Peninsula in Kotzebue Sound.

KEY FOR FLIGHT 32

- (GRAY WHALE)
- ◇ (WALRUS)
- (NO SIGHTING)
- △ (UNKNOWN PINNIPED)

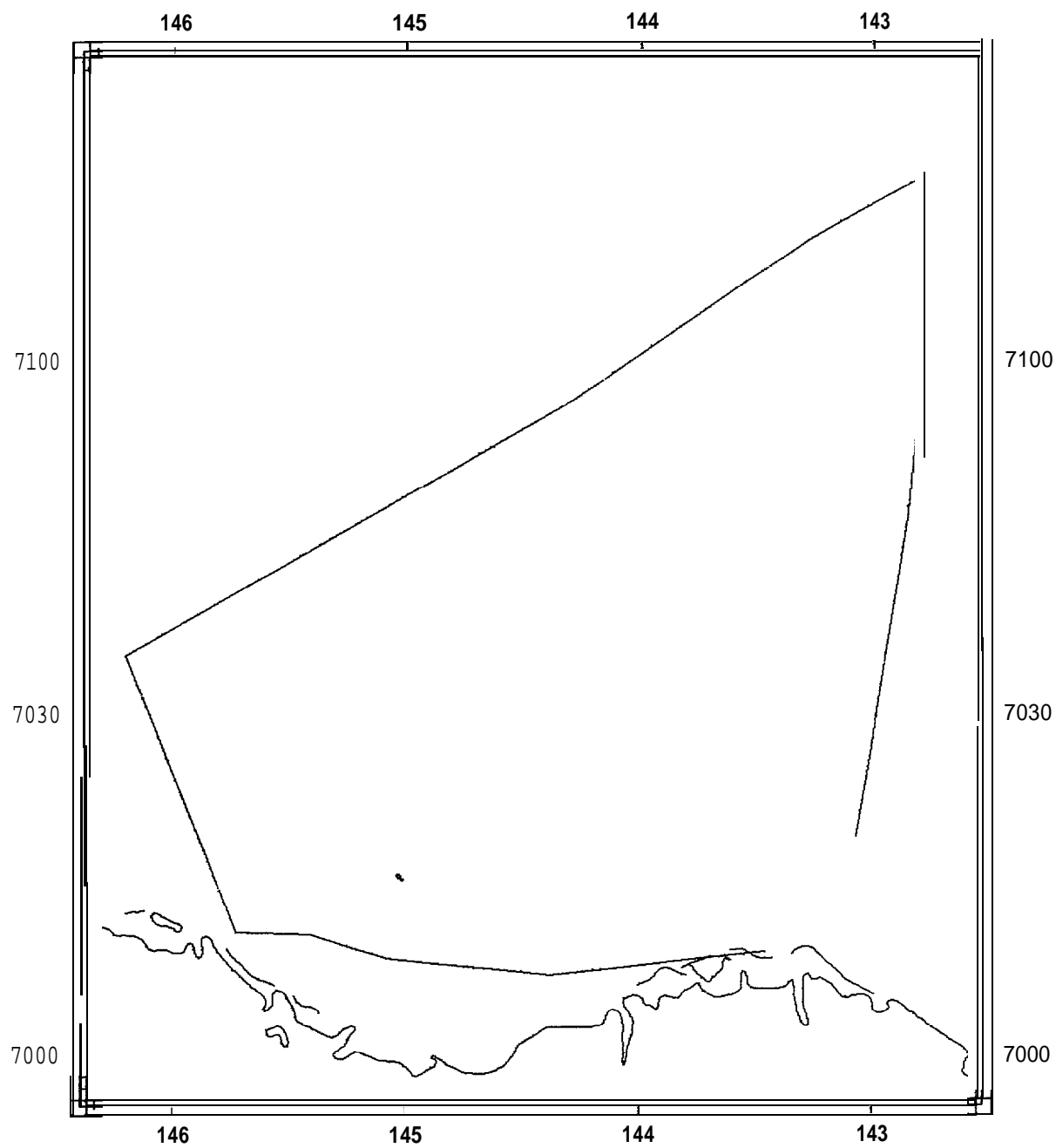
Flight #32, 31 July, 1982



Flight #32, 31 July 1981

Flight was a coastal survey from Kotzebue to Barter Island to relocate the operation base. Weather ranged from partly cloudy to overcast. Visibility from 5 km to unlimited. Sea state ranged from **Beaufort** 01 to 03. Ice **cover-**age was 7/10 between Wainwright and Barrow, and in the Beaufort Sea ranged from 5/10 to 9/10. One hundred eleven gray whales including 18 calves were seen between Cape Lisburne and the southern end of Peard Bay. Unidentified pinnipeds and walrus were seen between **Wainwright** and Pt. Barrow. Two gray whale carcasses and many headless walrus carcasses were seen on the beach between Kotzebue **and** Pt. Barrow. One **sonobuoy** was dropped, but no sounds were recorded due to recorder malfunction.

Flight #33, 1 August, 1982



A-70

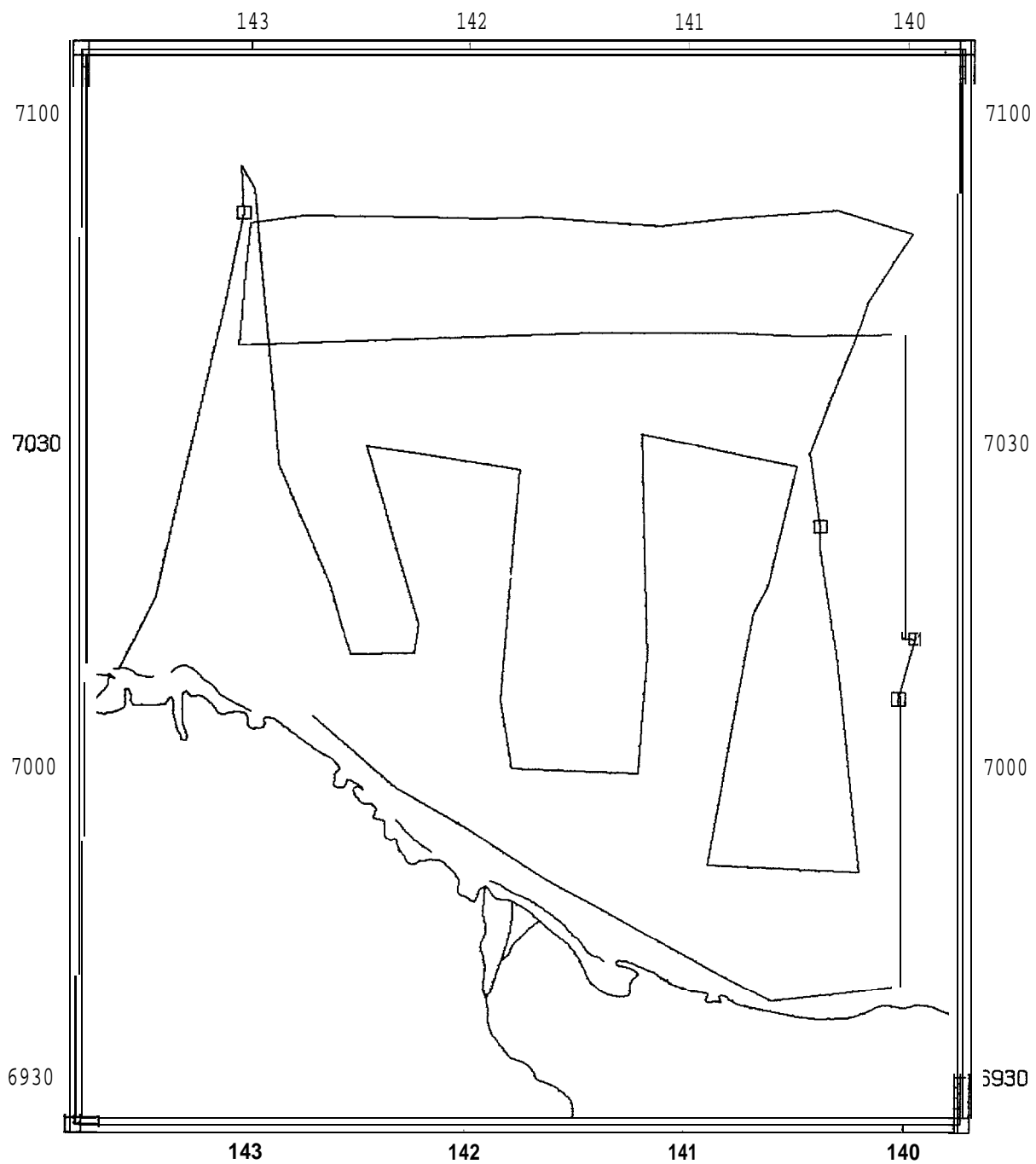
Flight #33, 1 August 1982

Flight was a search and ice reconnaissance survey between Barter Island and Deadhorse. Line transect surveys in blocks 8, 7 and 5 were aborted due to heavy fog resulting in unacceptable visibility. Ice data recorded through breaks in the fog showed near shore coverage to be 9/10. Sea State was Beaufort 00. No marine mammals were sighted.

KEY FOR FLIGHT 34

Flight #34, 2 August, 1982

□ (BOWHEAD WHALE)

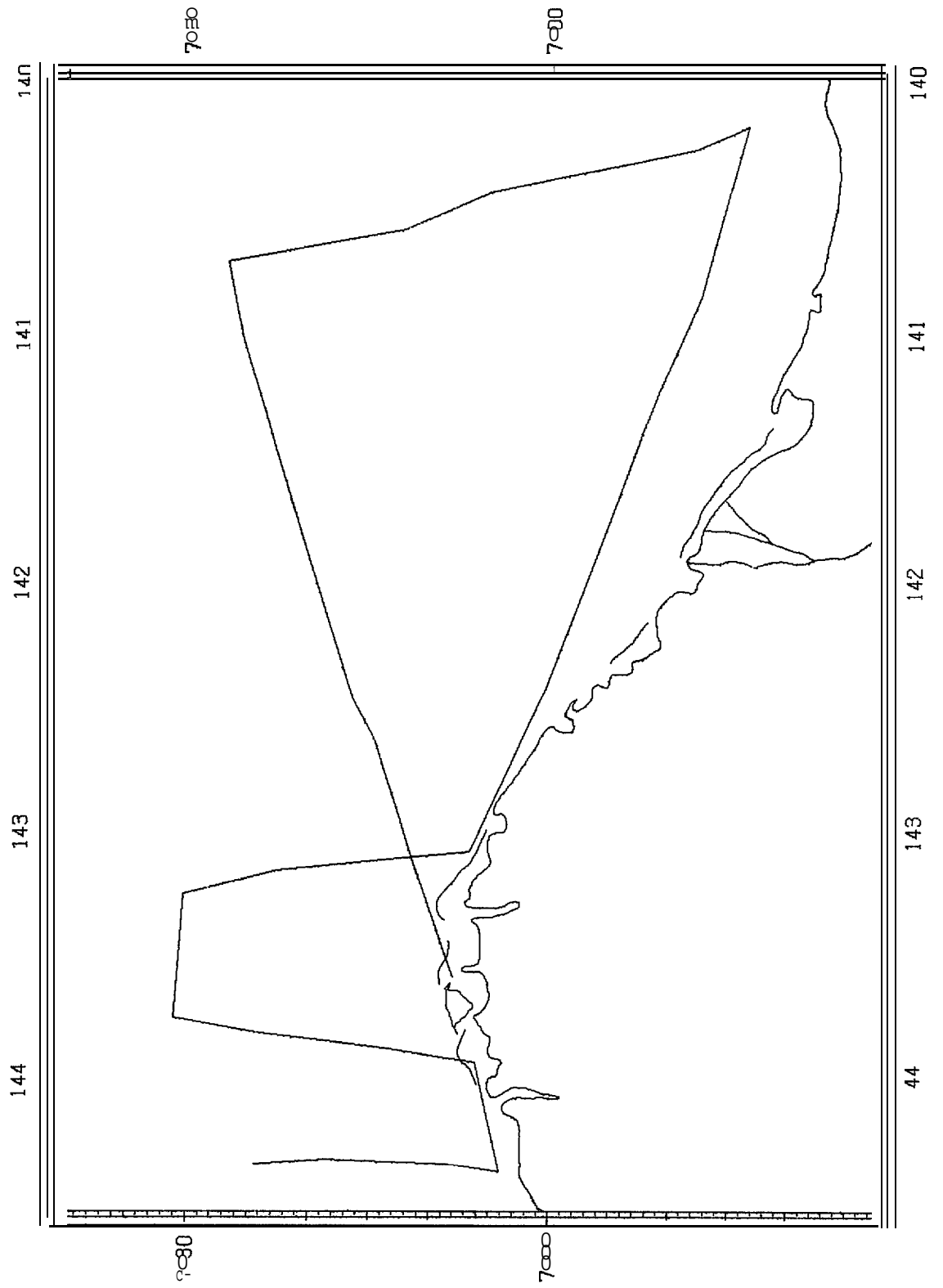


Flight #34, 2 August 1982

Flight was a line transect survey of block 5 with two east to west search lines north of **block** 5. Weather was partly cloudy to overcast with patches of fog. Visibility averaged 10 km. Ice coverage was 8/10 to 9/10. Sea state was Beaufort 00 to 02. Seven bowheads were seen east of Barter Island. One **sonobuoy** was dropped but no sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	70051.1 '	143°02.0'	264	BO	SS	320	9	0	915
1/0	70°22.3'	140°23.6'	938.3	BO	SS	330	6	2	48
3/0	70°11 .9'	139°57.6'	794.2	BO	GM	160	2	2	274
2/0	70°06.4'	140°02.0'	50704	BO	SW	300	2	2	51

Flight #35, 5 August, 1982



Flight #35, 5 August 1982

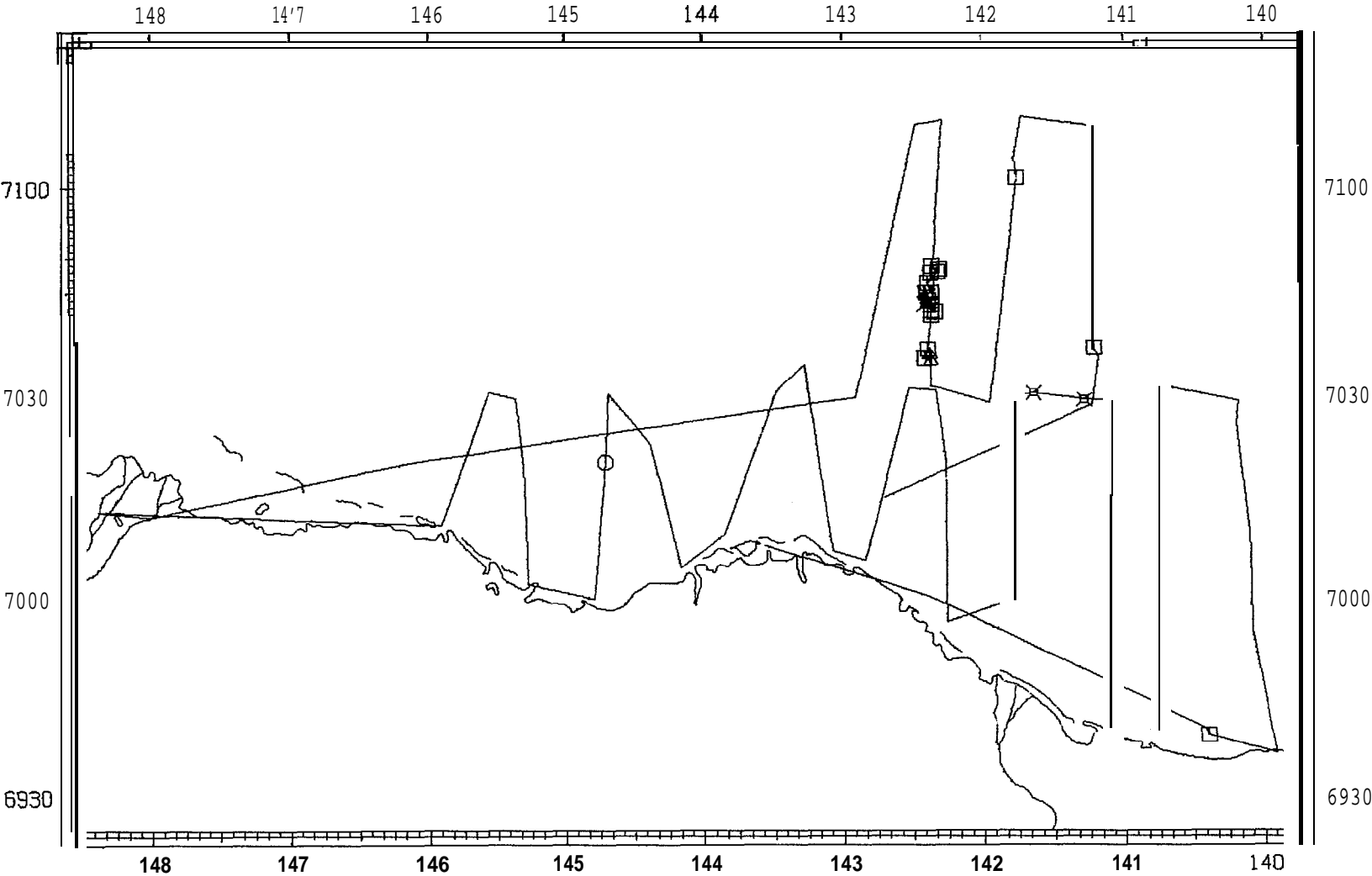
Flight was a line transect survey of the eastern 3 legs of block 4 after aborting transects in blocks 7 and 5 due to heavy fog. Weather was low overcast with areas of heavy fog. Visibility ranged from unacceptable to 10 km. Ice coverage was 9/10. Sea state was Beaufort 00 to 02. No marine mammals were sighted.

KEY F(3R FLIGHT 36

Flight #36, 6 August, 1982

- I (BOWHERD WHALE)
- A (BELUGA WHALE)
- ⊙ (POLAR BEAR)
- ✕ (UNKNOWN PINNIPED)

A-76



Flight #36, 6 August 1982

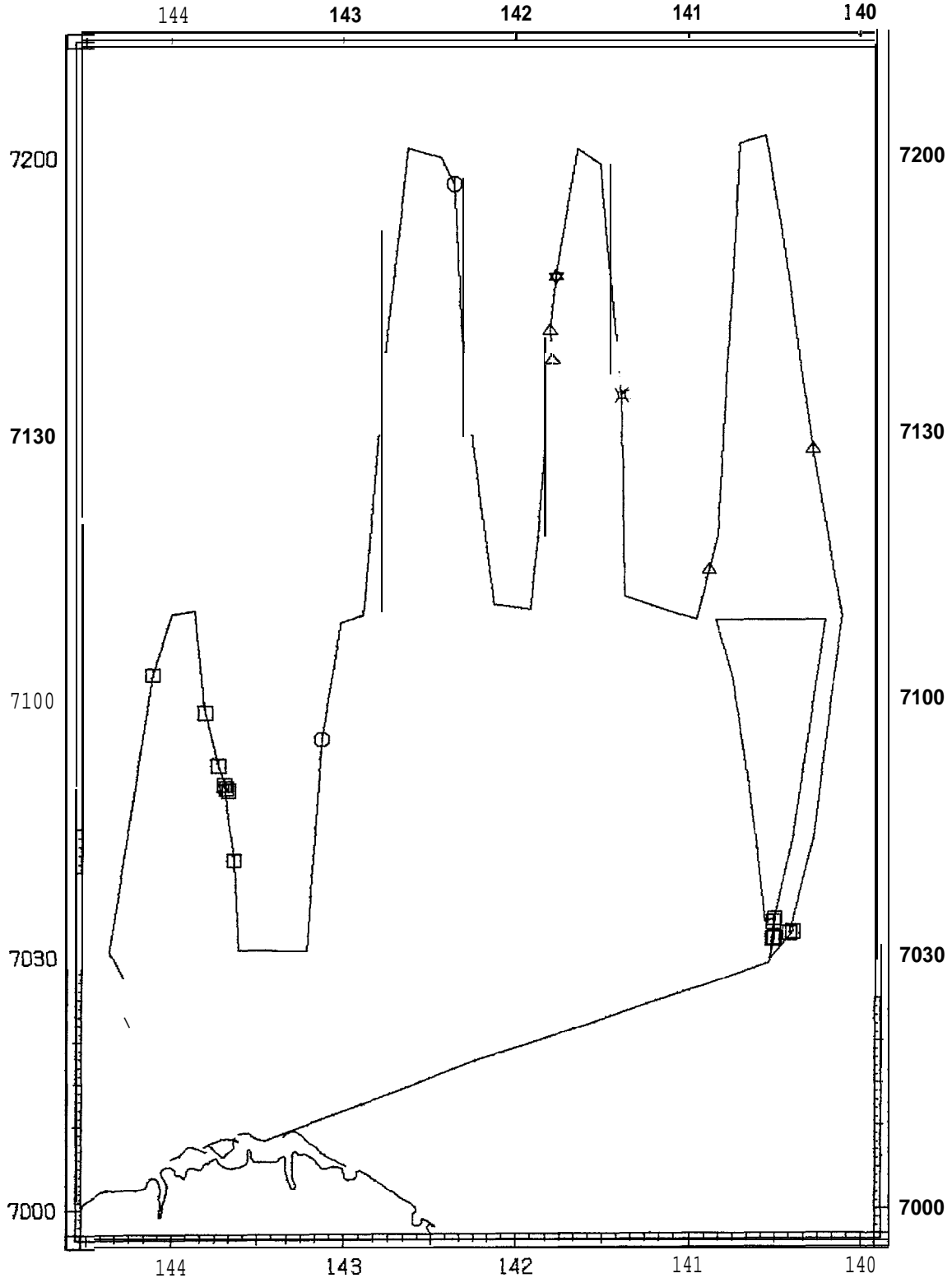
Flight was a line transect survey of blocks 4, 5 and the western half of 7. Weather was clear with unlimited visibility. Ice coverage was 9/10. Sea state was Beaufort 00. Thirty-two bowheads, belukhas, unidentified pinnipeds, and one polar bear were sighted northeast of Barter Island.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	69°39.4'	140°24.2'		BO	Ss		1	0	29
2/0	70°47.9'	142°22.4'	794.2	BW	Sw	340	9	0	1829
1/0	70°48.0'	142°19.4'	837.6	BO	Sw		9	0	1829
1/0	70°48.8'	142°21.8'	528.1	BO	Sw	270	9	0	1829
1/0	70°48.3'	142°18.9'	885.4	BO	Sw	240	9	0	1829
2/0	70°46.4'	142°23.8'		BO	Sw	340	9	0	1829
2/0	70°45.0'	142°22.2'		BO	Sw	330	9	0	1829
1/0	70°45.0'	142°24.5'		BO	Sw		9	0	1829
2/0	70°44.0'	142°23.5'		BO	Sw		9	0	1829
7/0	70°42.3'	142°20.6'		BO	SW	280	9	0	1829
1/0	70°43.3'	142°22.2'		BO	Sw		9	0	1829
1/0	70°42.5'	142°22.4'		BO	SW		9	0	1829
3/0	70°41.8'	142°22.2'		BO	Sw		9	0	1829
2/0	70°36.9'	142°23.6'		BO	Sw		9	0	1829
1/0	70°35.6'	142°25.2'		BO	Sw		9	0	1829
2/0	71°01.5'	141°45.7'	507.4	BO	Sw	030	9	0	2195
2/0	70°37.0'	141°13.3'	363.3	BO	Sw	360	9	0	1098

Flight #37, 7 August, 1982

KEY FOR FLIGHT 37

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- (POLAR BEAR)
- ☆ (UNKNOWN PINNIPED)



Flight #37, 7 August 1982

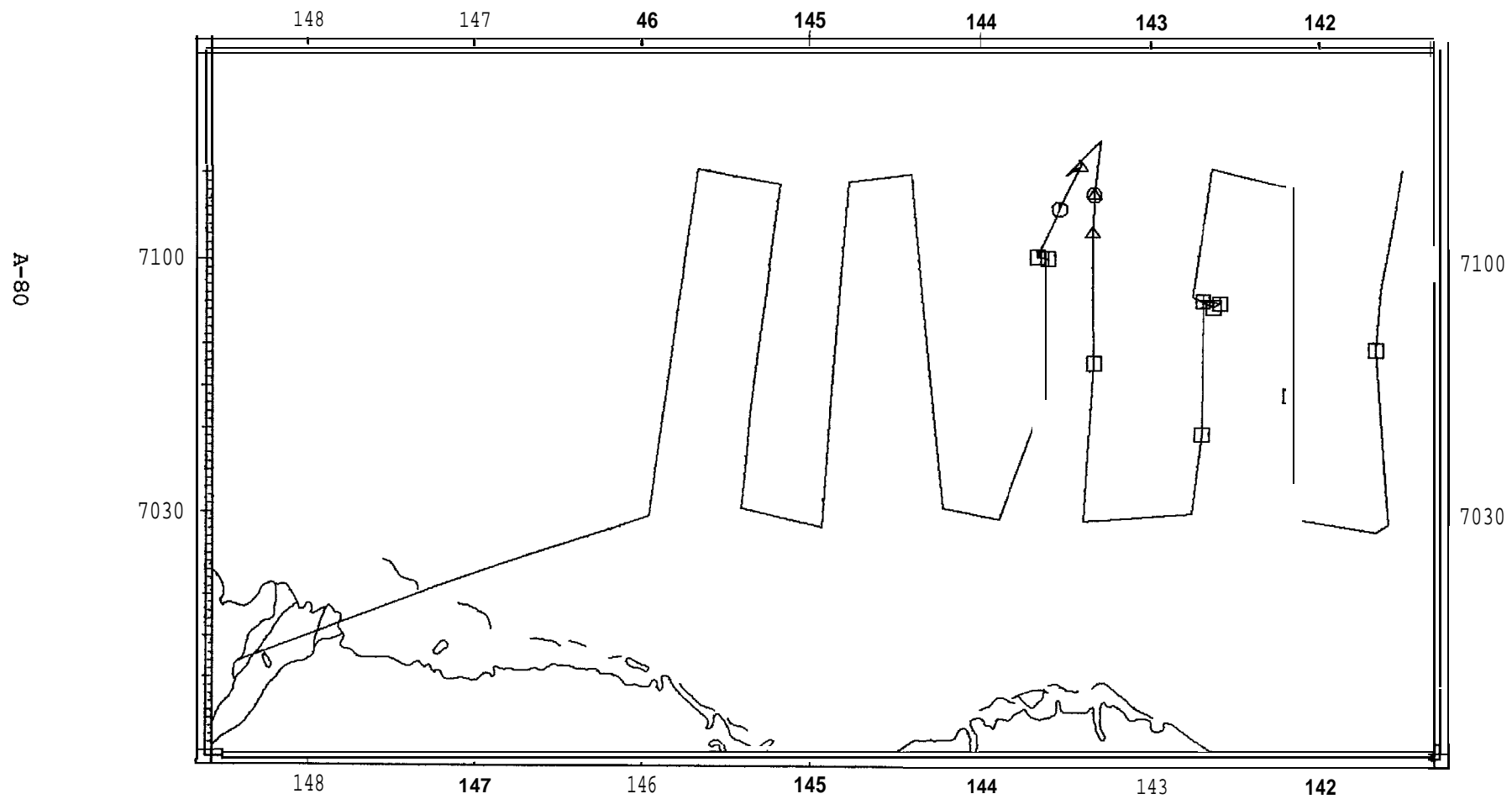
Flight was a line transect survey of the eastern third of block 7, block 7 and the eastern half of block 6. Weather was clear with unlimited visibility. Ice coverage was 9/10. Sea state was Beaufort 00 to 01. Twenty-seven bowheads, including 2 calves, were sighted northeast of Barter Island. Belukhas, a ringed seal, an unidentified pinniped and two polar bears were also sighted. One sonobuoy was dropped and many bowhead sounds recorded. Behaviors were photographed and video recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
2/0	70°32.2'	140°30.3'	359.6	BO	Sw	270	6	1	549
3/1	70°32.1'	140°30.8'	718.2	BO	Sw		6	1	549
1/0	70°34.4'	140°30.2'		BO	Sw	270	6	1	1829
2/0	70°34.0'	140°30.5'	404.6	BO	Sw		6	1	1829
1/0	70°32.9'	140°23.8'		BO	Sw	030	6	1	1829
1/0	70°32.7'	140°24.8'		BO	Sw	030	6	1	1829
1/0	70°41.41	143°38.4'	528.1	BO	Sw	270	6	0	439
1/0	70°50.2'	143°41.9'	1568.5	BO	Sw	090	6	0	439
2/0	70°49.5'	143°40.4'	718.2	BO	Sw	090	6	0	439
9/0	70°49.8'	143°41.2'	837.6	BO	Sw	270	6	0	439
1/0	70°52.4'	143°43.7'	363.3	BO	Sw	210	6	0	878
1/0	70°58.5'	143°48.5'	326.9	BO	Ss	270	6	0	1829
2/1	71°02.9'	144°06.8'	507.4	BO	Ss	360	6	0	1098

KEY F(IR FLIGHT 38

Flight #38, 8 August, 1982

- I (BOWHEAD WHALE)
- A (BELUGA WHALE)
- ⊙ (UNKNOWN PINNIPED)



Flight #38, 8 August 1982

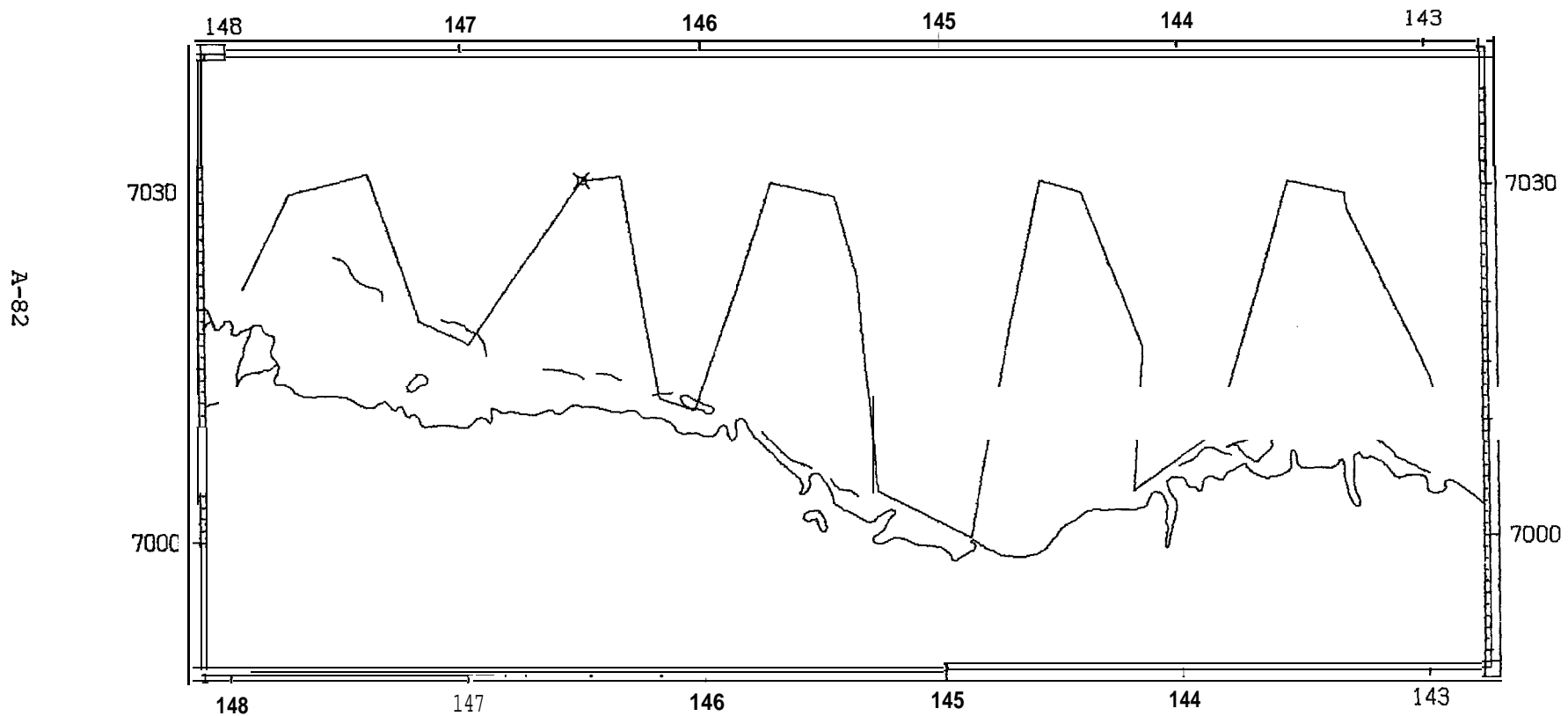
Flight was a line transect survey of block 6 and the western half of block 7. Weather was high overcast to the west with patches of fog to heavy fog where the transect was ended in block 7. Visibility ranged from unlimited to unacceptable. Ice coverage was 9/10. Sea state was Beaufort 00. Nineteen bowheads, **belukhas** and unidentified pinnipeds were sighted north of Barter Island. One **sonobuoy** was dropped and bowhead sounds recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	71°00.3'	143°36.7'	754.6	BO	Ss	060	9	0	1848
3/0	71°00.5'	143°40.2'	997.2	BO	Sw	330	9	0	1848
1/0	70°48.0'	143°20.5'	225.8	BO	Sw	270	9	0	732
1/0	70°39.6'	142°42.8'	363.3	BO	DI	120	9	0	366
5/0	70°55.4'	142°42.3'	1729	BO	Sw	270	9	0	1280
1/0	70°55.1'	142°36.4'	2603.2	BO	DI	210	9	0	1280
1/0	70°55.4'	142°42.3'	1568.5	BO	DI	120	9	0	1280
1/0	70°54.7'	142°38.8'			DI				1280
1/0	70°44.3'	142°11.4'	350.7	BO	Ss	240	9	0	274
4/0	70°49.6'	141°40.3'	469.5	BO	GS	270	9	0	1848

KEY FOR FLIGHT 39

Flight #39, 11 August, 1982

✕ [RINGED SEAL]



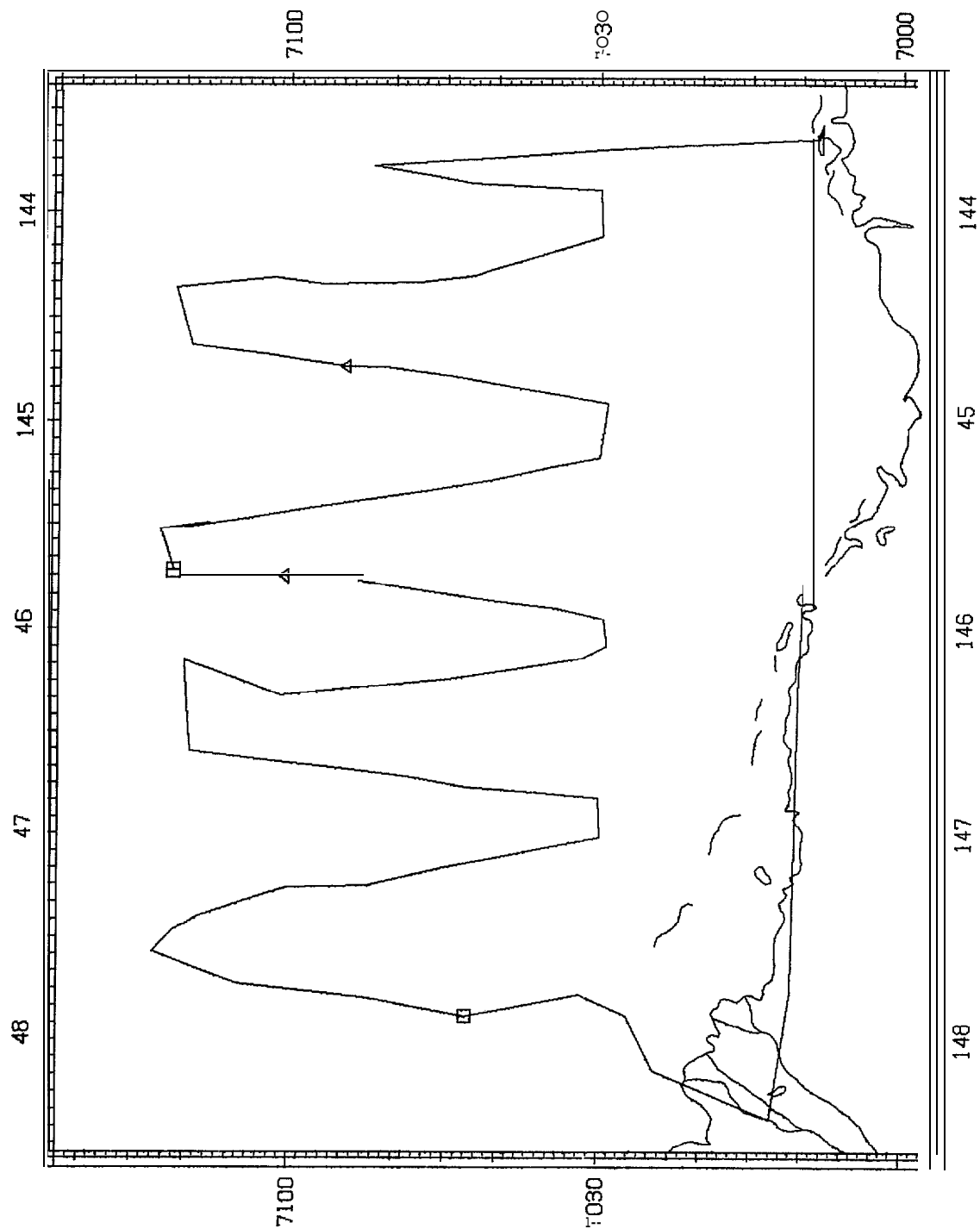
Flight #39, 11 August 1982

Flight was a line transect survey of block 4 with its western boundary extended to **138°W** longitude. Weather ranged from partly cloudy to areas with patchy fog. Visibility was 2 km to unlimited. Ice coverage was 9/10 with a narrow corridor of open water extending approximately 1 km from shore. Sea state was **Beaufort** 00 to 01 . No bowhead whales were sighted. Ringed seals were the only marine mammals seen.

KEY FOR FLIGHT 40

- △ (BELUGA WHALE)
- (UNKNOWN PINNIPED)

Flight #40, 12 August, 1982

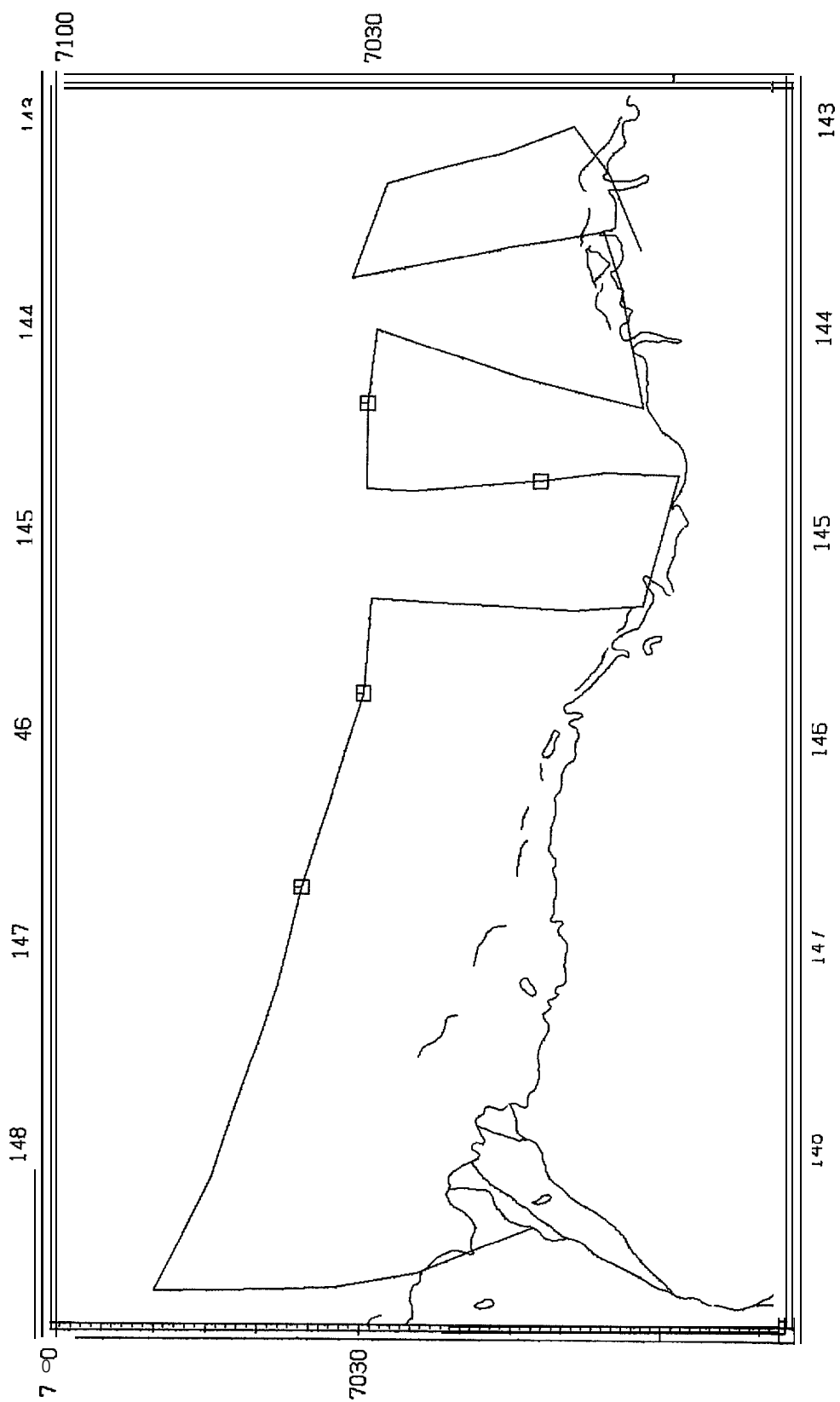


Flight #40, 12 August 1982

Flight was a transect survey of blocks 1, 2, and 6. The weather was partly cloudy with portions of patchy and heavy fog. Visibility was generally unlimited. Sea state **ranged** from Beaufort 00 to 03. Ice coverage averaged 8/10 of broken floe. **Belukhas** were the only marine mammals sighted. One **sonobuoy** was dropped but no sounds were recorded.

Flight #41, 14 August, 1982

UNKNOWN P NZ_0WD



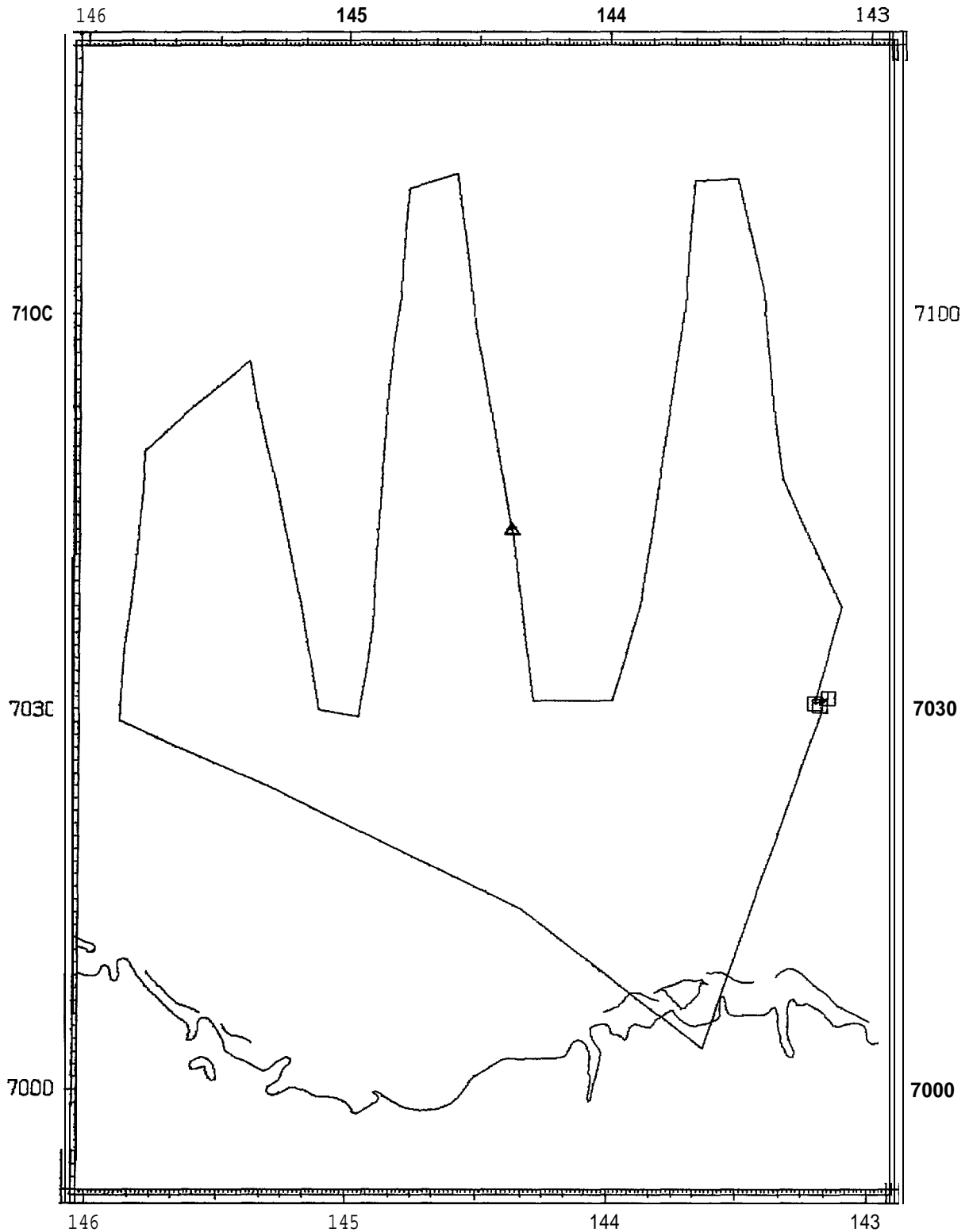
Flight #41 , 14 August 1982

Flight was a transect survey of block 4. The weather was partly cloudy. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage averaged 6/10 of broken floe. Unidentified pinnipeds were the only marine mammals sighted. One **sonobuoy** was dropped but no sounds were recorded.

KEY FOR FLIGHT 42

Flight #42, 14 August, 1982

□ (BOWHEAD WHALE)
A (BELUGA WHALE)



Flight #42, 14 August 1982

Flight was a transect survey of block 6. The weather ranged from partly cloudy to heavy fog. **Visibility** was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage average 8/10 broken floe. Three bowheads and **belukhas** were sighted north of Barter Island.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
1/0	70°30.2'	143°11.3'	190.5	BO	SS	180	5	0	48
1/0	70°30.8'	143°09.5'	304.9	BO	SS	270	5	0	48
1/0	70°30.4'	143°12.4'	304.9	BO	SS	270	5	0	48

KEY FOR FLIGHT 43

□ (BOWHEAD WHALE)

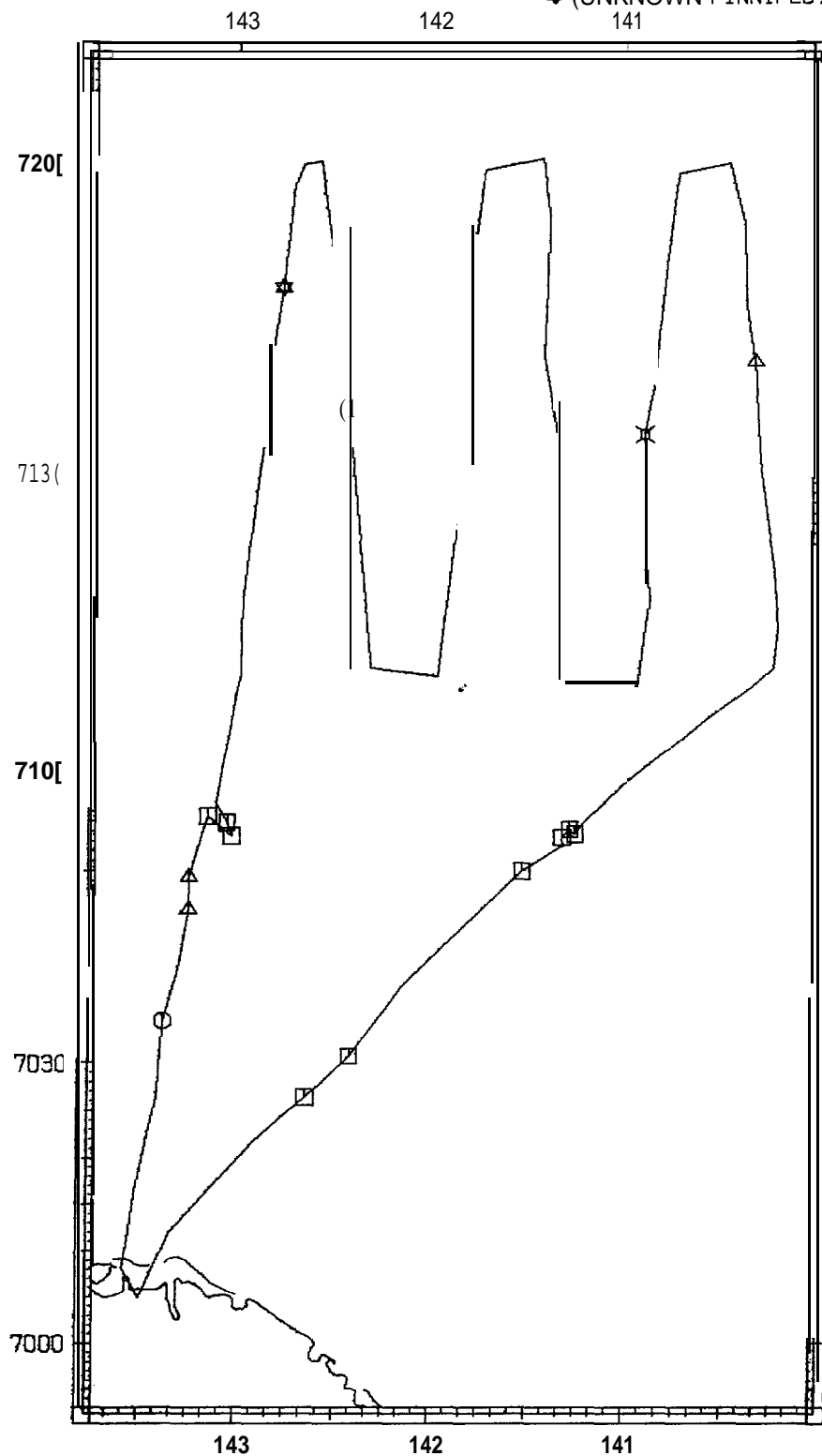
▲ (BELUGA WHALE)

M (RINGED SEAL)

○ (POLAR BEAR)

✱ (UNKNOWN PINNIPED)

Flight #43, 15 August, 1982



Flight #43, 15 August 1982

Flight was a transect survey of block 7. The weather ranged from **clear** to patch fog. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 03. **Ice** coverage averaged 6/10 to 7/10 broken floe. Twenty bowheads, including three calves, were sighted northeast of Barter Island. **Belukhas**, polar bears and a ringed seal were **also** sighted. Two **sonobuoys** were dropped and whale sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
8/1	70°55.4'	143°08.8'	528.1	BO	GM		7	0	1829
2/1	70°53.4'	143001.3'	452	BO	cc	210	7	0	1892
1/0	70°54.8'	143°02.8'	573.4	BO	Ss		7	0	1892
1/0	70°53.6'	141015.1'	213.5	BO	Ss	210	7	1	1892
1/0	70°53.6'	141015.1'	213.5	BO	Ss	240	7	1	1892
1/0	70°54.1'	141°16.8'	363.3	BO	Ss	270	7	1	1892
1/0	70°53.3'	141019.1'	404.6	BO	Ss		7	1	1892
1/0	70°49.9'	141031.5'	2169.3	BW	DI		7	1	1892
2/0	70°30.8'	142°25.3'	1706.7	BO	GM		8	1	79
2/1	70°26.5'	142°38.8'	3254	BO	cc	090	8	1	59

◆ {UNKNOWN PINNIPED}



Flight #44, 16 August 1982

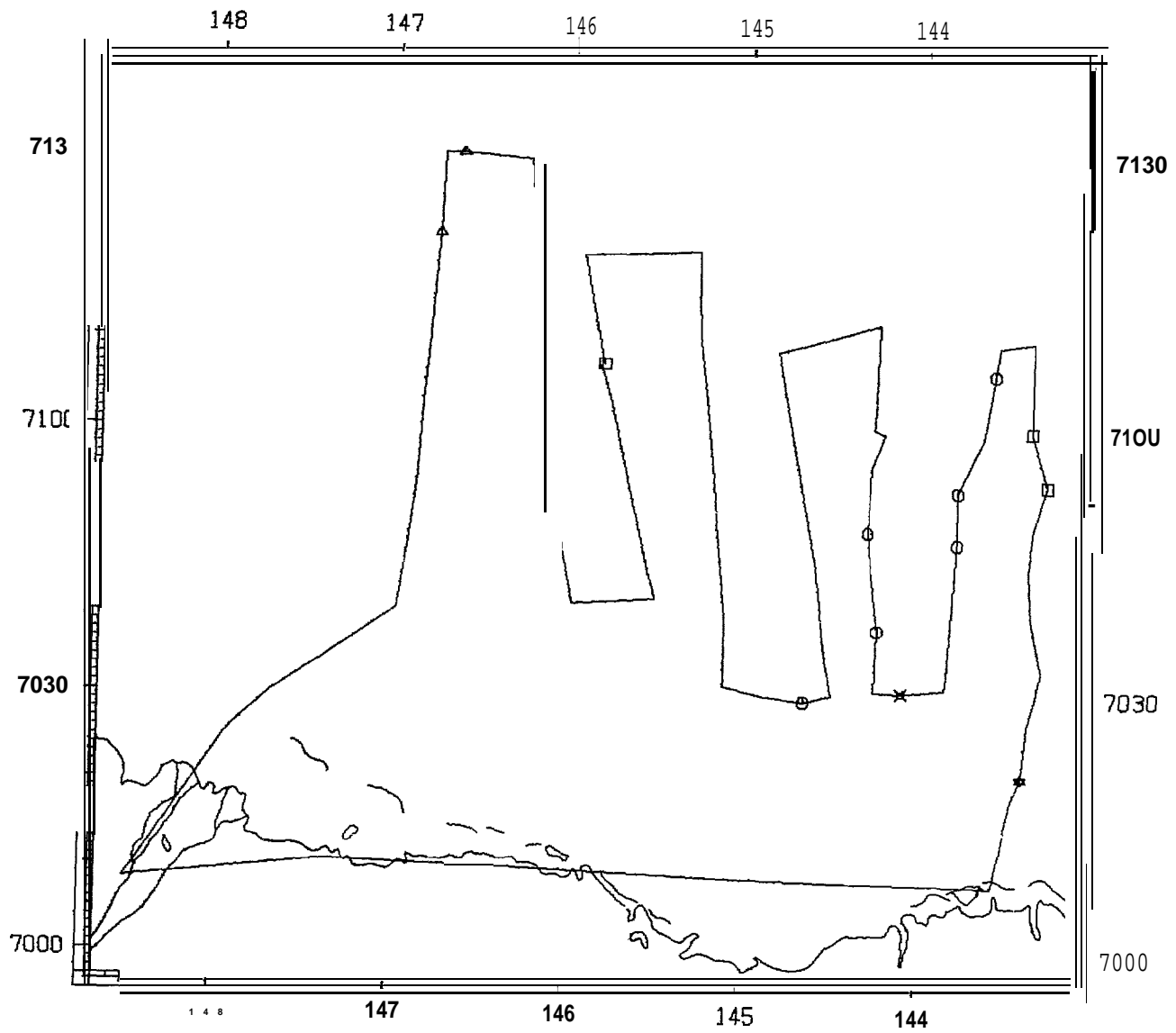
Flight was a transect survey of parts of blocks 5, 6, and 7. The weather was partly cloudy with small areas of patchy and heavy fog. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage was 7/10 to 8/20 broken floe. Fourteen bowheads, including one calf, **belukhas** and a polar bear were sighted northeast of Barter Island. Two **sonobuoys** were dropped and whale sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
3/0	70°55.1'	142°39.7'	4360	BO	GM	330	4	0	549
9/1	70°54.3'	142°43.0'		BO	GM	270	4	0	549
1/0	71°09.8'	143°14.3'	1729	BO	DI	250	8	0	1829
1/0	71°01.9'	143°26.7'	653.8	BO	SS	040	7	0	1829

KEY FOR FLIGHT 45

Flight #45, 17 August, 1982

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- ✕ (RINGED SEAL)
- ★ (BEARDED SEAL)
- (UNKNOWN PINNIPED)



Flight #45, 17 August 1982

Flight was a transect survey of blocks 6 and north extended block 2. The weather ranged from partly cloudy to low ceiling conditions. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage was 7/10 to 8/10 broken floe. Three bowheads, **belukhas**, bearded seals, and ringed seals were sighted north of Camden Bay. Two **sonobuoys** were dropped but no whale sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	70°53.9'	143°17.7'	35901		BO DI	030	8	2	1829
1/0	70°59.9'	143023.1	1084.7	WD	DI		7	2	1098
1/0	71°07.2'	145°48.8'	255.8		BO DI	150	7	2	549

- ☐ (BOWHEAD WHALE)
- A (BELUGA WHALE)
- ✱ (BEARDED SEAL)
- ⊙ (UNKNOWN PINNIPED)

A-96

Flight #46, 18 August 1982

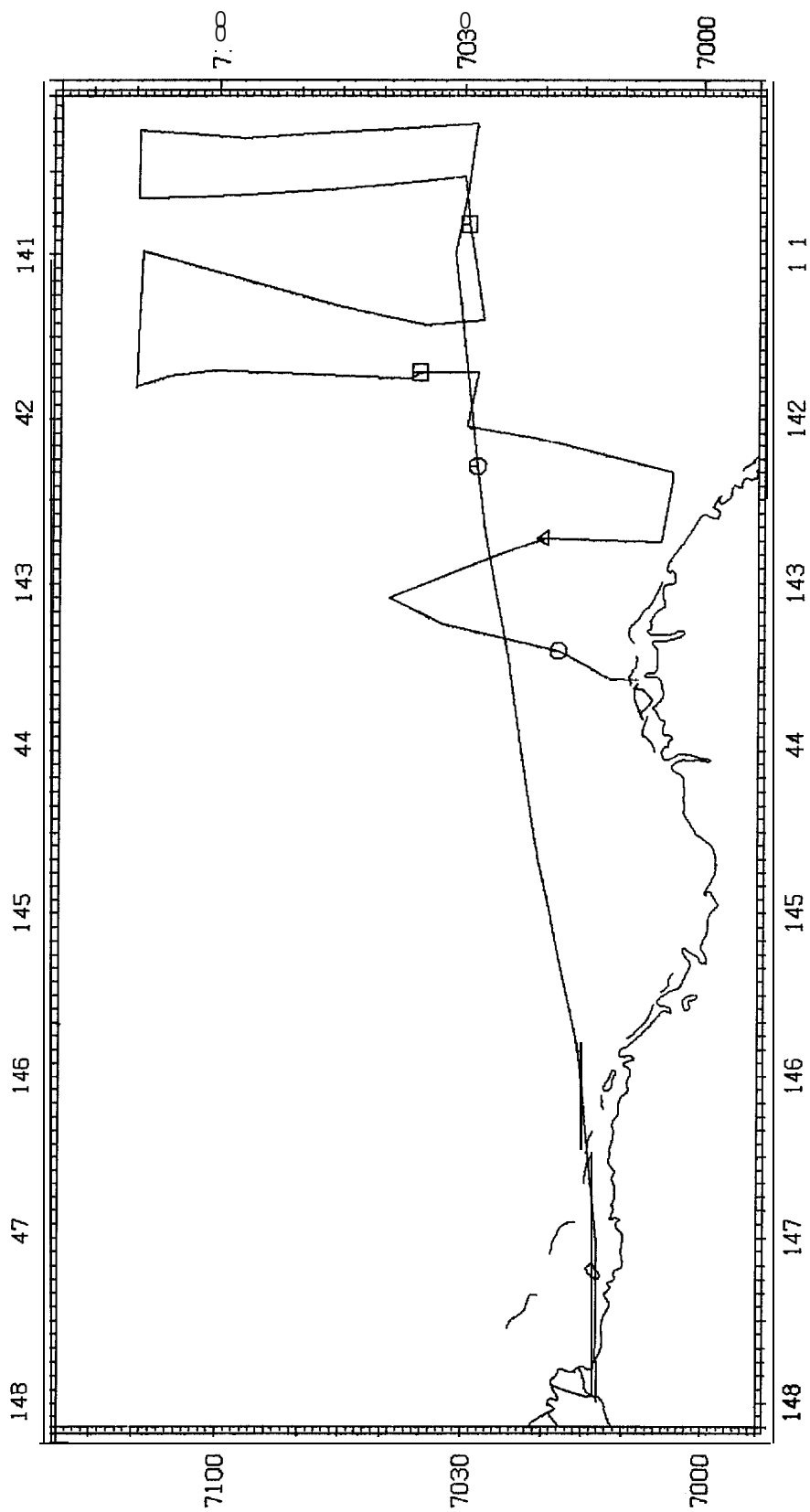
Flight was a transect survey of east extended block 5 and block 7. The weather ranged from clear to partly cloudy. Visibility was unlimited. Sea state ranged from Beaufort 00 to 04. Ice coverage was 6/10 to 8/10 broken floe. Fourteen bowheads, including four calves, **belukhas** and bearded seals were sighted east of Barter Island. Three **sonobuoys** were dropped but no whale sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
2/0	70°30.6'	139°33.1 '	255.8	SP	TL		0	4	732
2/0	70°18.0'	139°47.2'	1307.6	BO	Sw	180	7	2	366
2/1	70°13.9'	139°45.2'	255.8	BO	Sw	150	7	2	274
1/0	70°07.8'	139°42.8'	284.3	BO	Ss		6	2	51
2/1	70°22.5'	140°12.0'	1307.6	BO	GS	360	8	2	91
2/0	70°24.4'	140°46.4'	511.6	BO	Ss	240	8	2	55
2/1	70°14.9'	140°43.5'	107.5	BO	cc	240	8	2	51
2/1	70°15.1 '	140°42.6'	167.5	BO	cc		8	2	51
1/0	70°27.7'	141°19.1'	3136.9	BO	Sw	300	8	1	311

KEY FOR FLIGHT 47

- (BOWHEAD WHALE)
- ▲ (BELUGA WHALE)
- (UNKNOWN PINNIPED)

Flight #47, 20 August, 1982



Flight #47, 20 August 1982

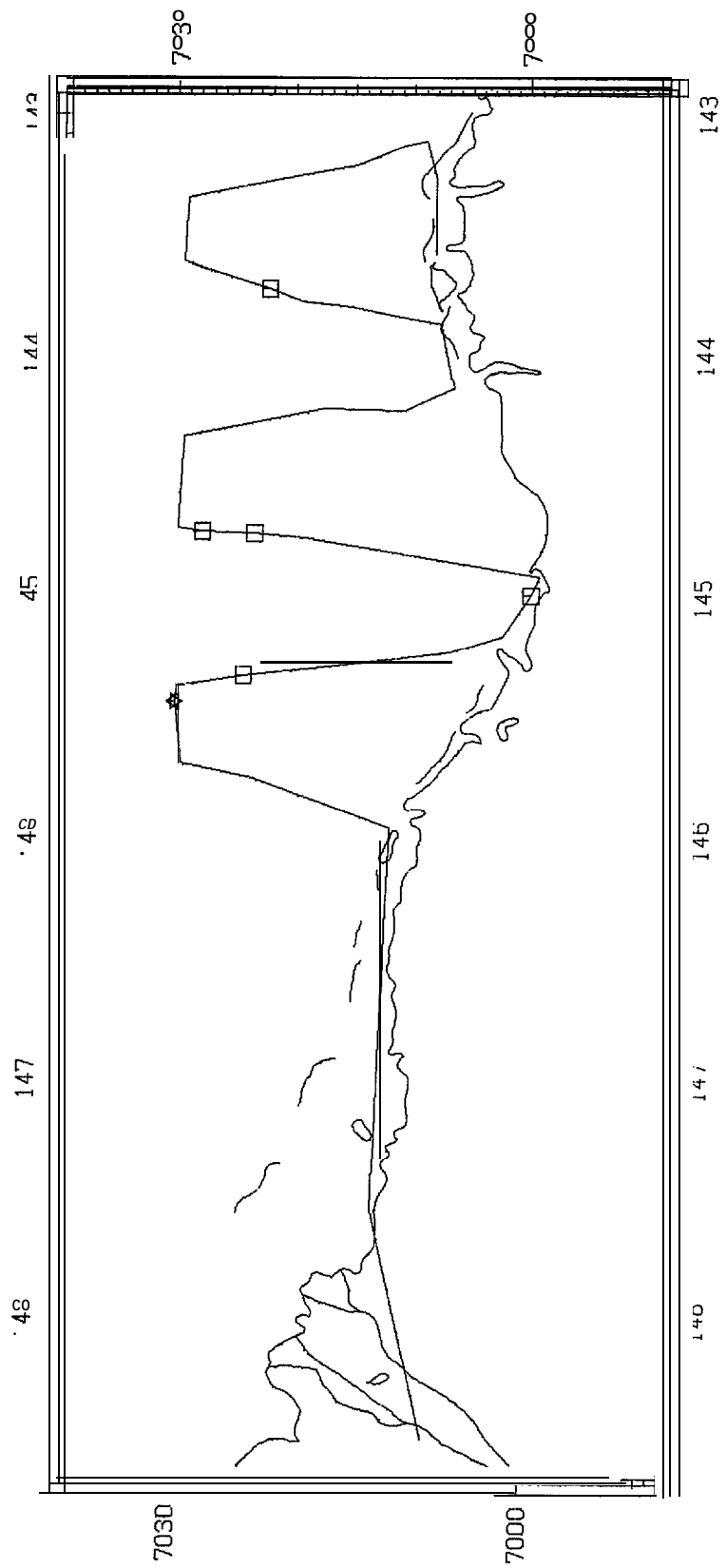
Flight was a transect survey of block 7 and part of block 4. The weather was overcast. Visibility was unlimited. Sea state ranged from Beaufort 01 to 05. Ice coverage was 7/10 to 9/10 broken floe. Two bowheads, including one calf, and **belukhas** were sighted northeast of Barter Island. Two **sonobuoys** were dropped but both malfunctioned.

T# /C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/1	70°35.5'	141°42.9'	870.8	BO	CC	260	8	B1	366
1/0	70°29.5'	140°49.3'	1056.1	BO	SS	240	8	B3	457

KEY FOR FLIGHT 48

- ☆ (BEARDED SEAL)
- (UNKNOWN PINNIPED)

Flight #48, 20 August, 1982



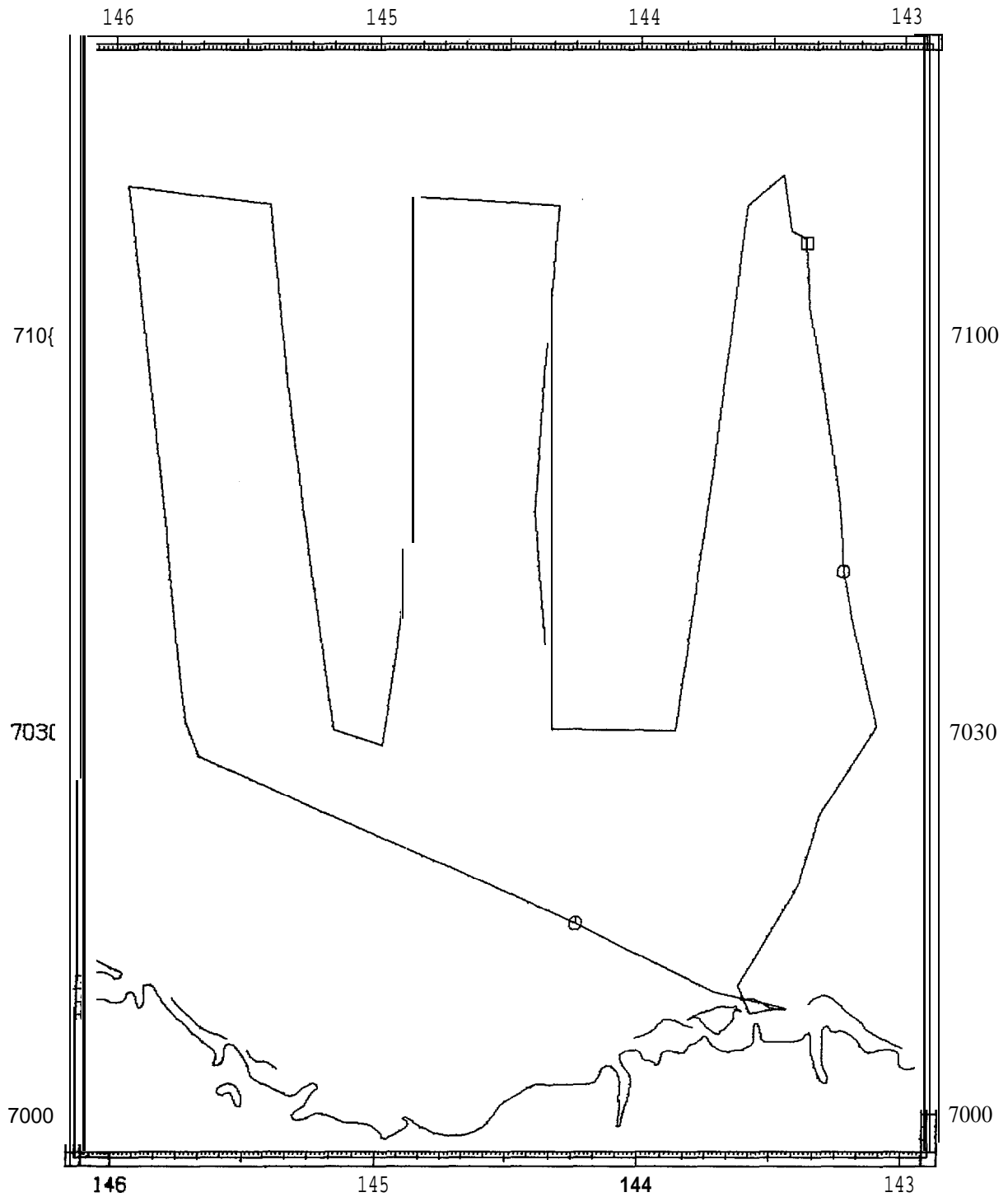
Flight #48, 20 August 1982

Flight was a transect survey of block 4. The weather was overcast. Visibility was unlimited. Sea state ranged from Beaufort 00 to 05. Ice coverage was 6/10 to 8/10 broken floe. No bowheads, but one bearded seal were sighted.

KEY F(3R FLIGHT 49

Flight #49, 21 August, 1982

□ (BOWHEAD WHALE)
○ (UNKNOWN PINNIPED)



Flight #49, 21 August 1982

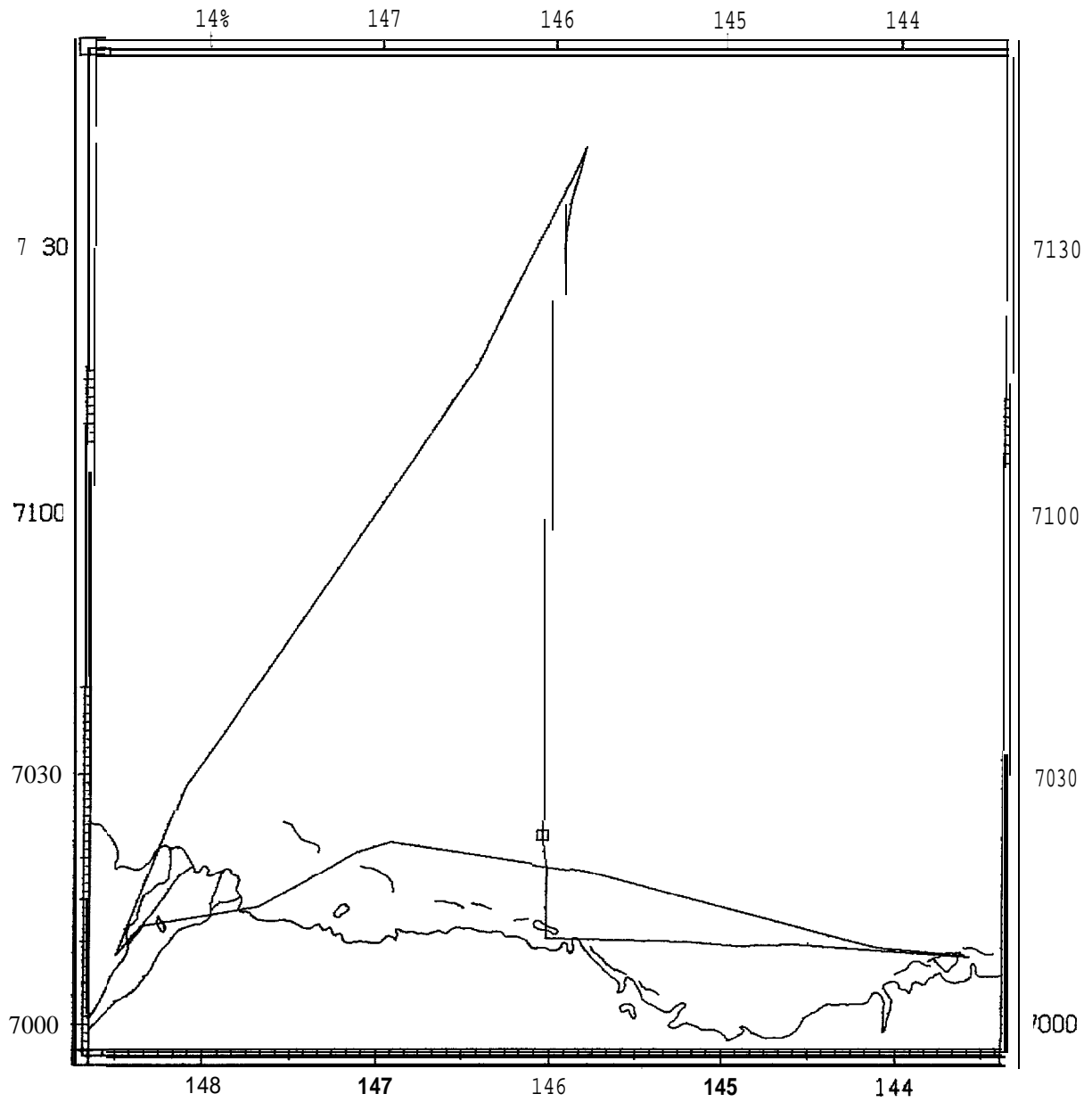
Flight was a transect survey of block 6. The weather ranged from partly cloudy to overcast. Visibility was generally unlimited. Sea state ranged from Beaufort 03 to 05. Ice coverage was 6/10 to 7/10 broken floe. One bowhead was sighted north of Barter Island. Two **sonobuoys** were dropped but no sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°06.8'	143°22.3'	361.6	BO	330		6	3	2195

KEY F(IR FLIGHT 50

Flight #50, 22 August, 1982

□ (UNKNOWN PINNIPED)



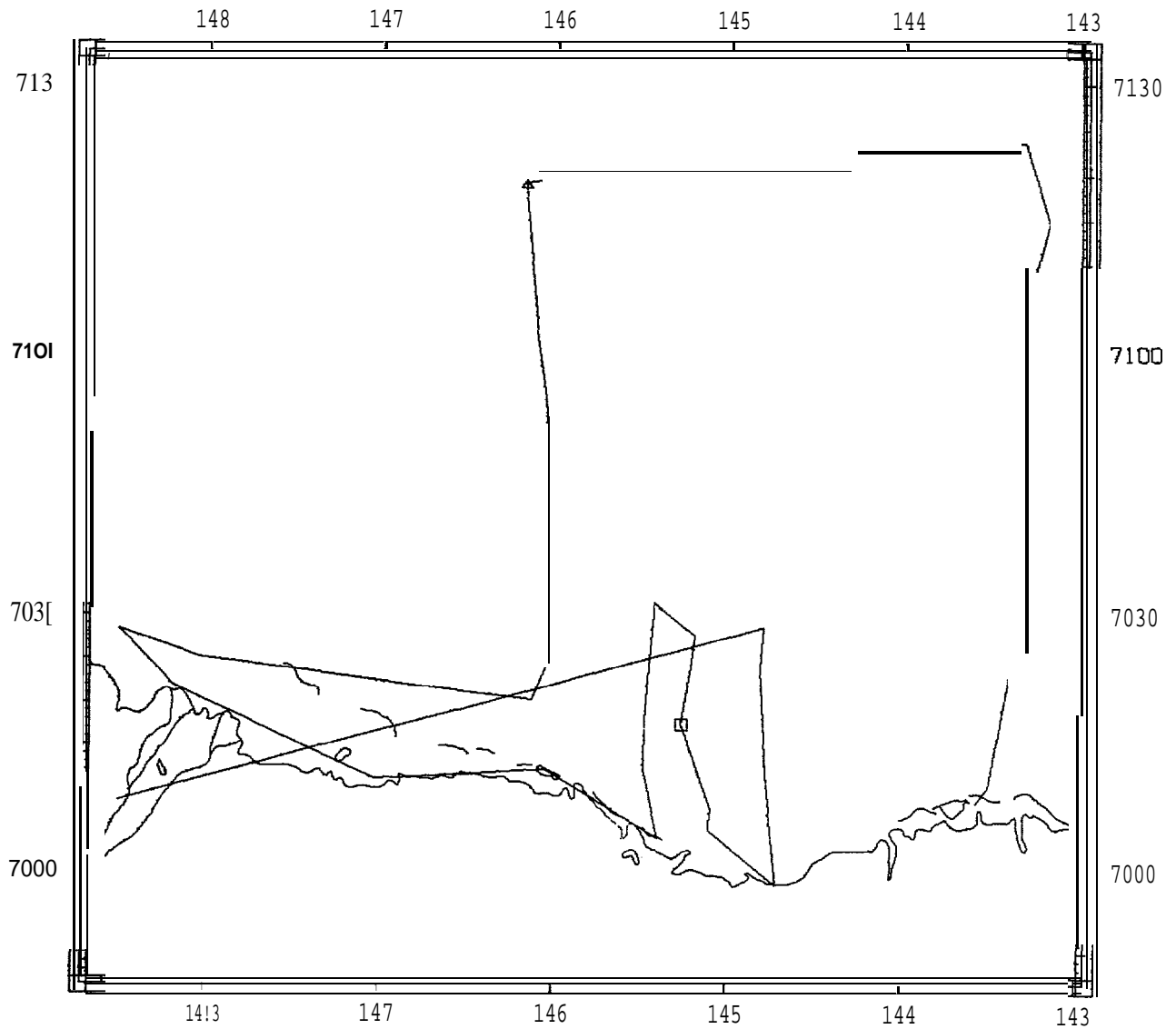
Flight #50, 22 August 1982

Flight was a search survey of the eastern edge of block 1. The weather ranged from partly cloudy to heavy fog. Visibility was generally unacceptable. Sea state ranged from Beaufort 00 to 03. Ice coverage was 3/10 to 4/10 broken floe. One unidentified **pinniped** was seen.

KEY FOR FLIGHT 51

Flight #51, 23 August, 1982

△ (BELUGA WHALE)
□ (UNKNOWN PINNIPED)



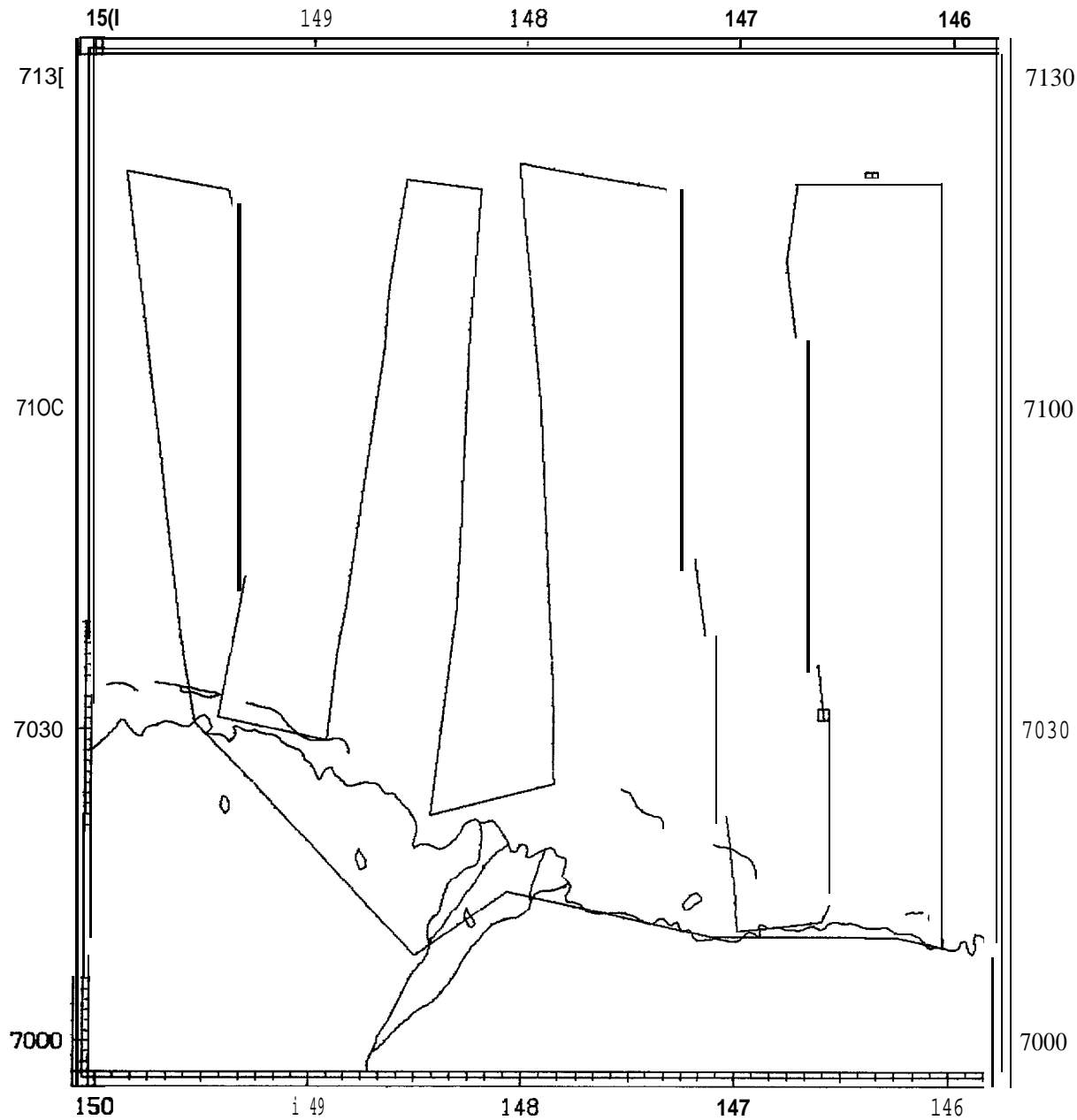
Flight #51, 23 August 1981

Flight was a transect survey of Blocks 6 and 4. The weather ranged from partly cloudy to heavy **fog**. Visibility was generally unacceptable. Sea state ranged from Beaufort 00 to 05. Ice coverage averaged 7/10 broken floe. One **belukha** whale was the only marine mammal seen.

KEY FOR FLIGHT 52

Flight #52, 24 August, 1982

□ (UNKNOWN PINNIPED)



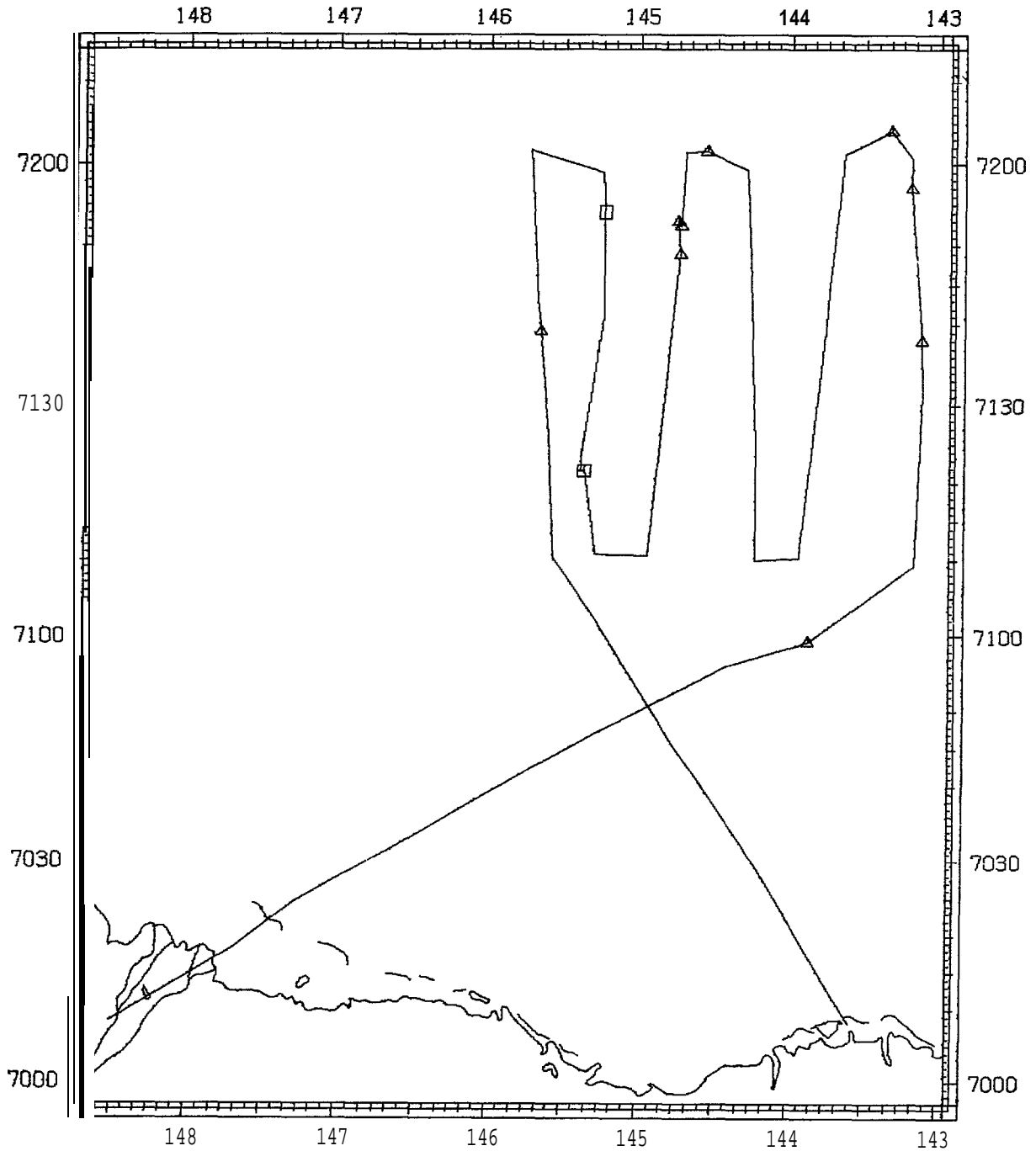
Flight #52, 24 August 1982

Flight was a transect survey of blocks 1 and 2. The weather was clear, the visibility was unlimited. Sea state ranged from Beaufort 03 to 05. Ice coverage was 1/10 to 3/10 broken floe. Four unidentified pinnipeds were the only mammals seen.

KEY FOR FLIGHT 53

Flight #53, 24 August, 1982

□ (BOWHEAD WHALE)
A (BELUGA WHALE)



Flight #53, 24 August 1982

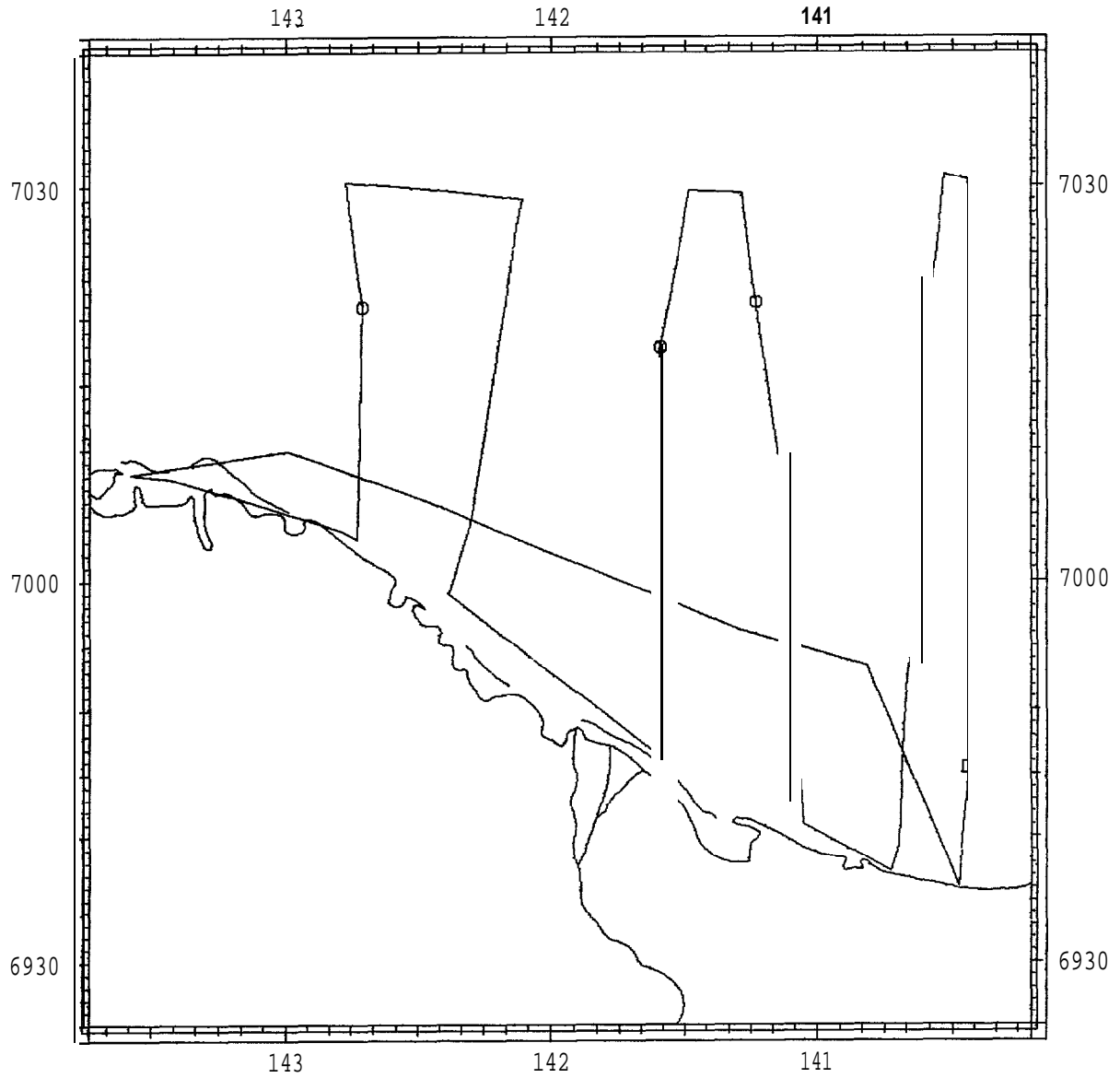
Flight was a transect survey of block 9. The weather was clear. Visibility was unlimited. Sea state ranged from Beaufort 01 to 05. Ice coverage was 6/10 to 8/10 broken floe. Two bowheads and belukhas were sighted northwest of Barter Island. One sonobuoy was dropped but no sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°21.6'	145°21.9'	609.8	BO	SW	240	5	4	1829
1/0	71054.1'	145°14.2'	1056.1	BW	SW	280	7	4	3293

KEY FOR FLIGHT 54

Flight #54, 25 August, 1982

- (BOWHEAD WHALE)
- ⊙ (UNKNOWN PINNIPED)



Flight #54, 25 August 1982

Flight was a **transect** survey of block 5. The weather was clear, and visibility was unlimited. Sea state ranged from Beaufort 02 to 05. **Ice** coverage was 7/10 to 9/10 broken floe. One bowhead was sighted north of Demarcation Bay.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HOG	ICE	SS	DEPTH (M)
1/0	69°45.5'	140°26.4'	837.6		BO DI 90			4	31

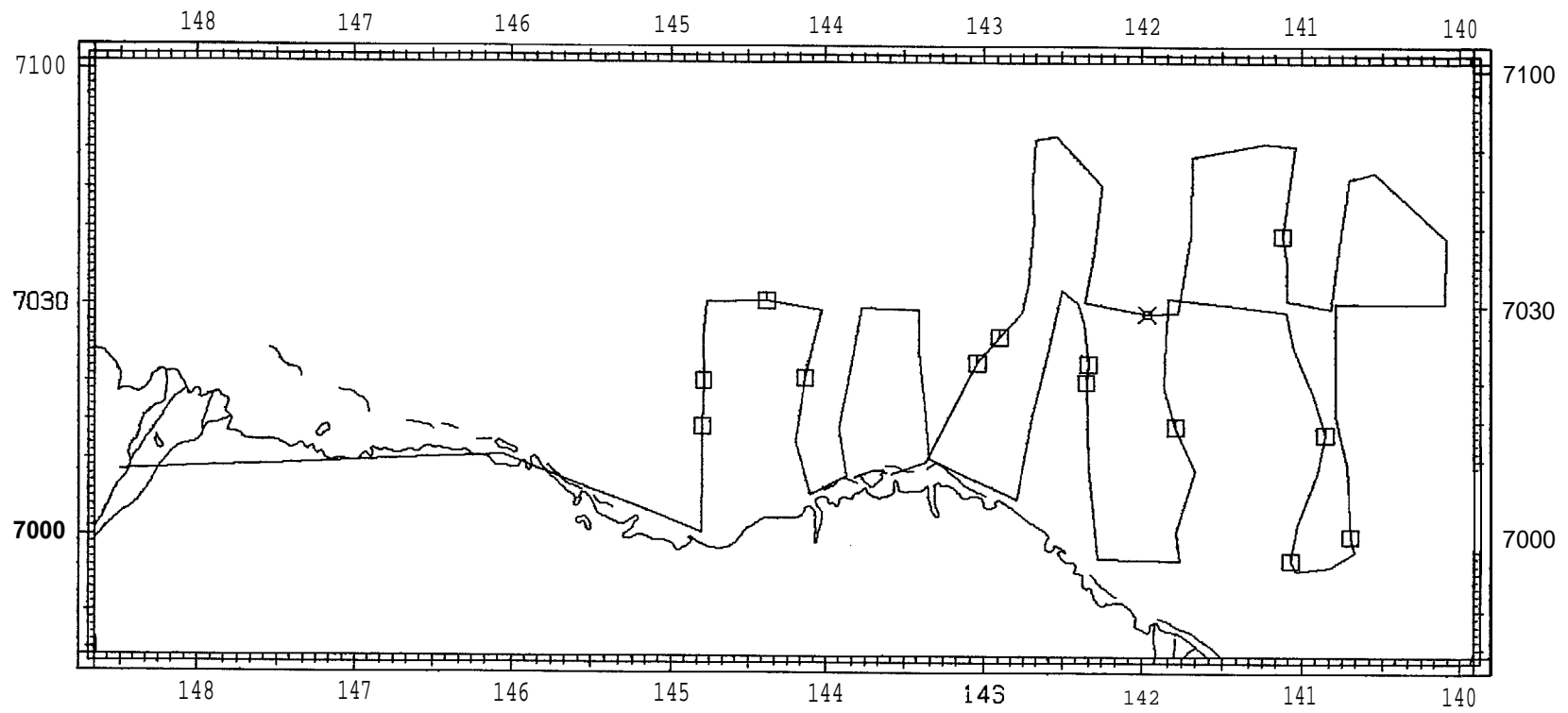
KEY FOR FLIGHT 55

Flight #55, 28 August, 1982

✕ [RINGED SEAL]

•1 [UNKNOWN PINNIPED]

A-114



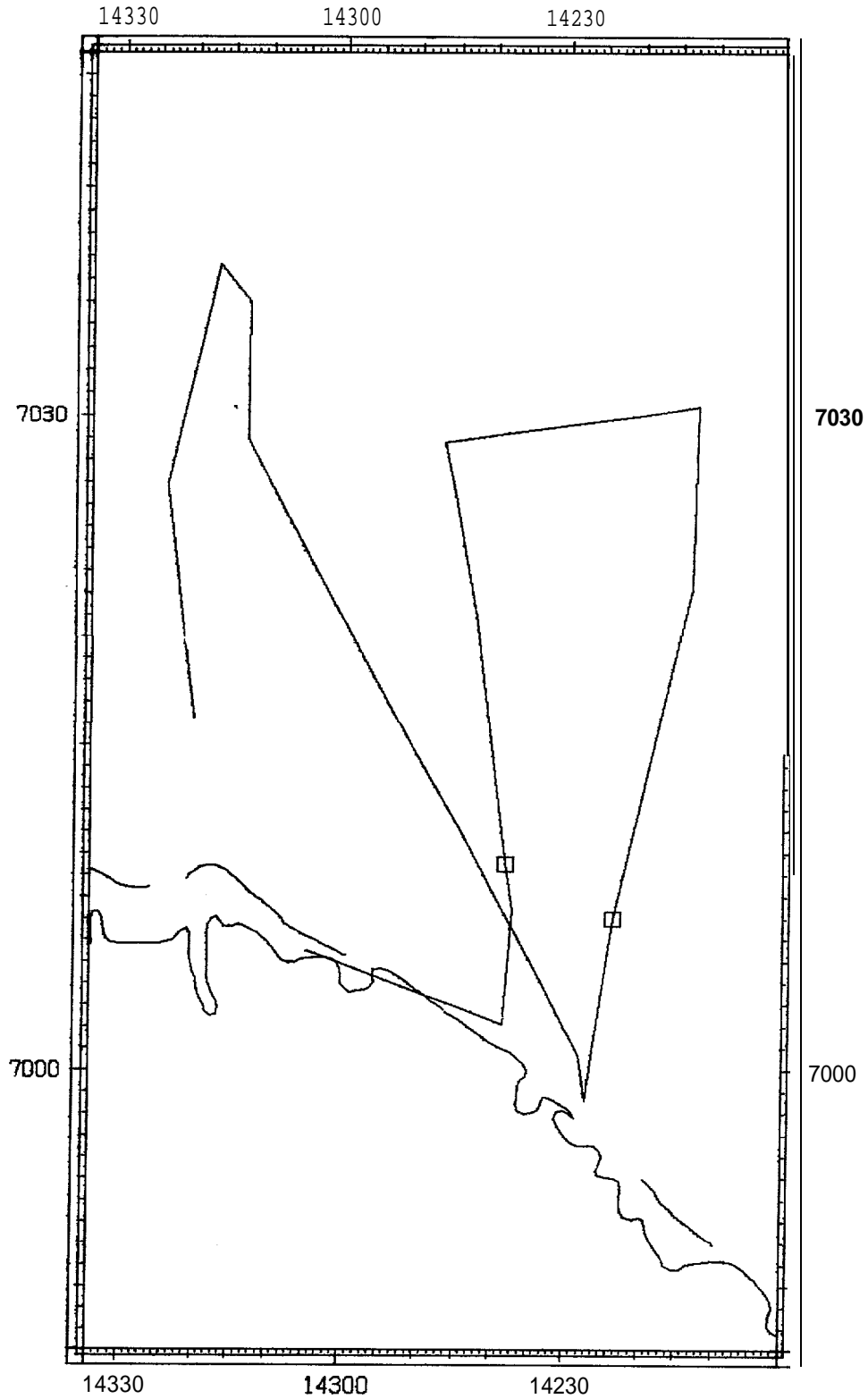
Flight #55, 28 **August** 1982

Flight was a transect survey of blocks 7, 5, and 4. The weather ranged from patchy fog to overcast. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 03. Ice coverage was 7/10 to 9/10 broken floe. No bowheads were sighted, but ringed seals were.

KEY FOR FLIGHT S6

Flight #56, 1 September, 1982

□ (UNKNOWN PINNIPED)



Flight #56, 1 September 1982

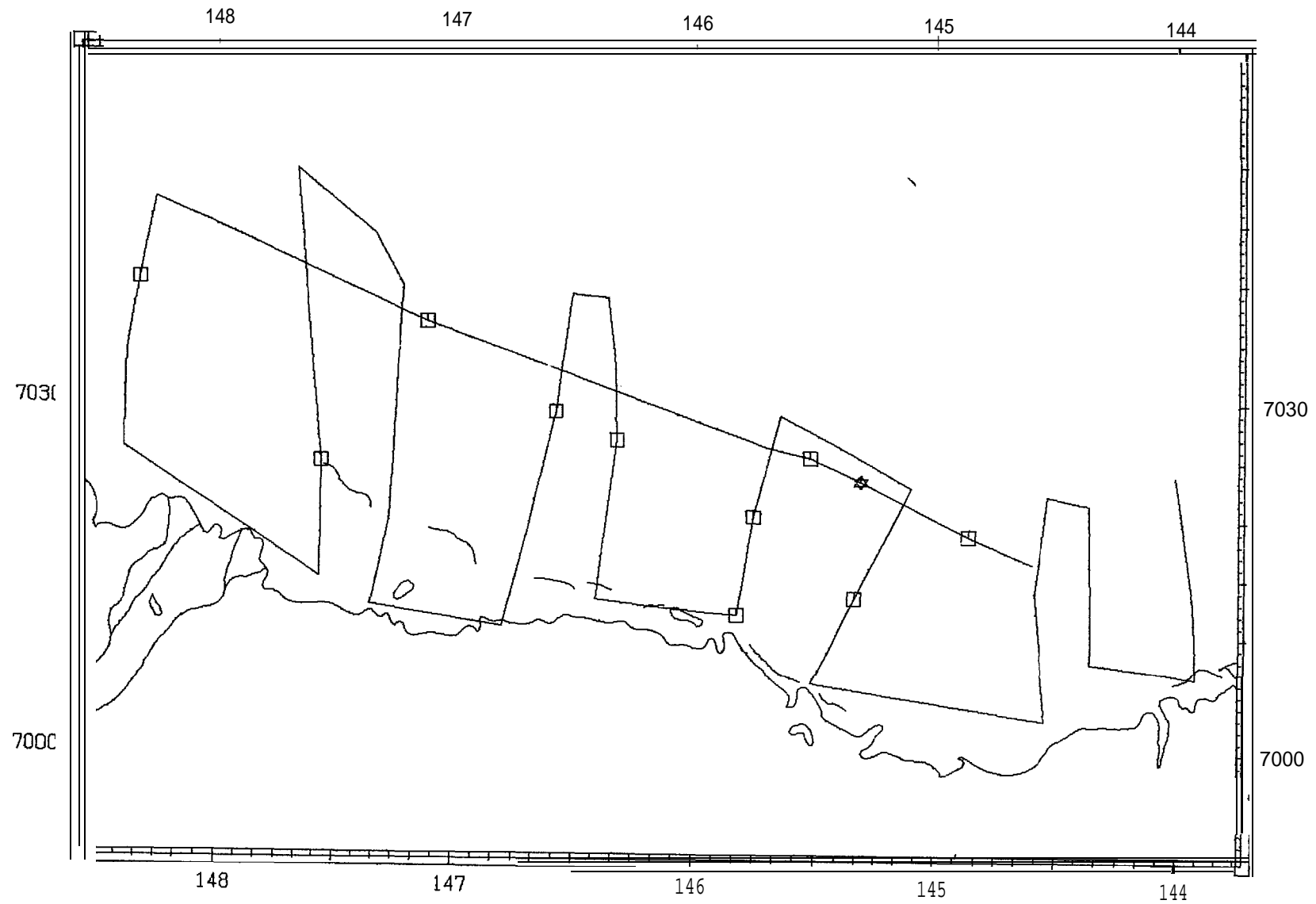
Flight was a partial transect survey of block 5. The weather ranged from overcast to heavy fog. Visibility was generally unacceptable. Sea state ranged from Beaufort 00 to 02. Ice coverage was 4/10 broken floe. No bow-heads were sighted, but ringed seals were.

KEY FOR FLIGHT 57

Flight #57, 1 September, 1982

✱ (BEARDED SEAL)
 □ (UNKNOWN PINNIPED)

A-118



Flight #57, 1 September 1982

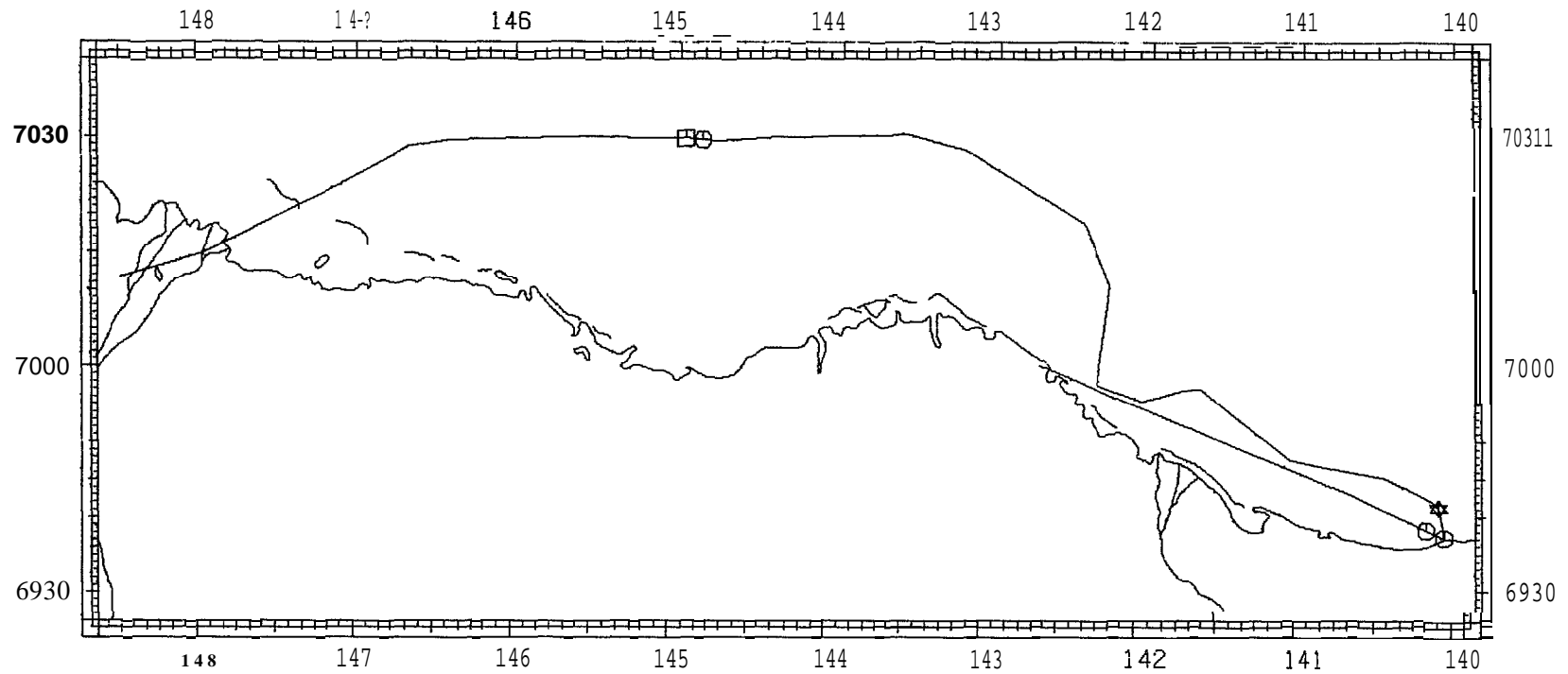
Flight was a transect survey of Block 1 and 4. The weather generally consisted of patchy fog. Visibility varied from poor to unlimited. The sea state ranged from Beaufort 00 to 03. Ice coverage was primarily 3/10 broken floe. No bowheads were sighted, but bearded seals were. One **sonobuoy** was dropped but no sounds were recorded.

KEY FOR FLIGHT 58

Flight #58, 2 September, 1982

- (BOWHEAD WHALE)
- ★ (BEARDED SEAL)
- (UNKNOWN PINNIPED)

A-120



Flight #58, 2 September 1982

Flight was a search survey in block 5. The weather ranged from patchy fog to heavy fog. Visibility was generally unacceptable. Sea **state** ranged from Beaufort 00 to 02. Ice coverage was 3/10 broken floe. One bowhead and one bearded seal were sighted in Camden Bay. One **sonobuoy** was dropped, but no sounds were recorded.

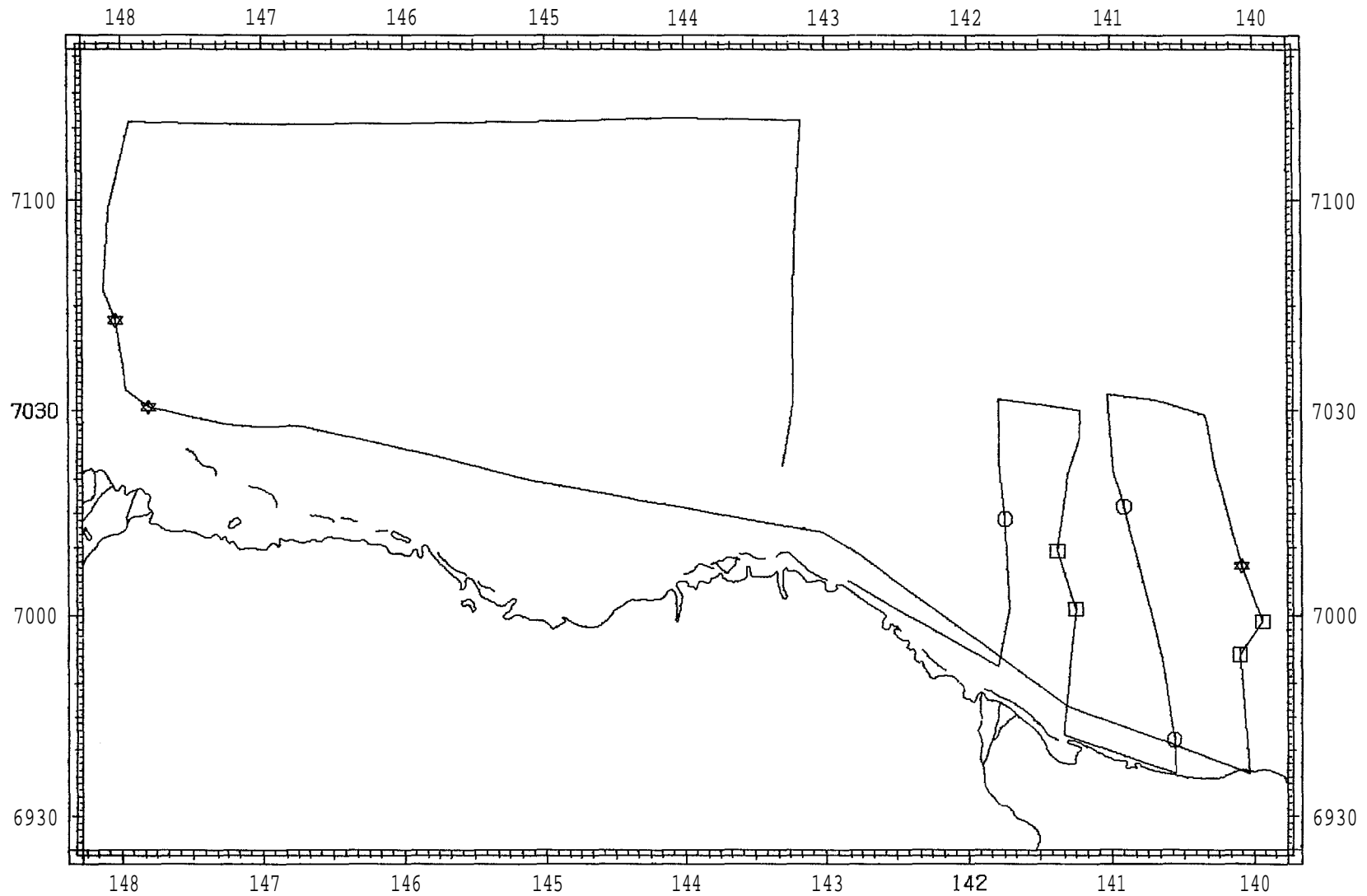
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	70°29.7'	144°53.3'	528.1	BO	SS	240	3	2	55

KEY FOR FLIGHT 59

Flight #59, 4 September, 1982

- (BOWHEAD WHALE)
- ★ (BEARDED SEAL)
- (UNKNOWN PINNIPED)

A-122



Flight #59, 4 September 1982

Flight was a transect survey of block 5 and a search **survey** along the perimeter of blocks 4 and 6. The weather ranged from patchy fog to heavy fog. The visibility was mostly unacceptable, but ranged to unlimited late in the survey. Sea state ranged from Beaufort 01 to 02. Ice coverage was 2/10 to 4/10 broken floe. Five bowheads and bearded seals were sighted east of Barter Island. One **sonobuoy** was dropped, but no whale sounds were recorded.

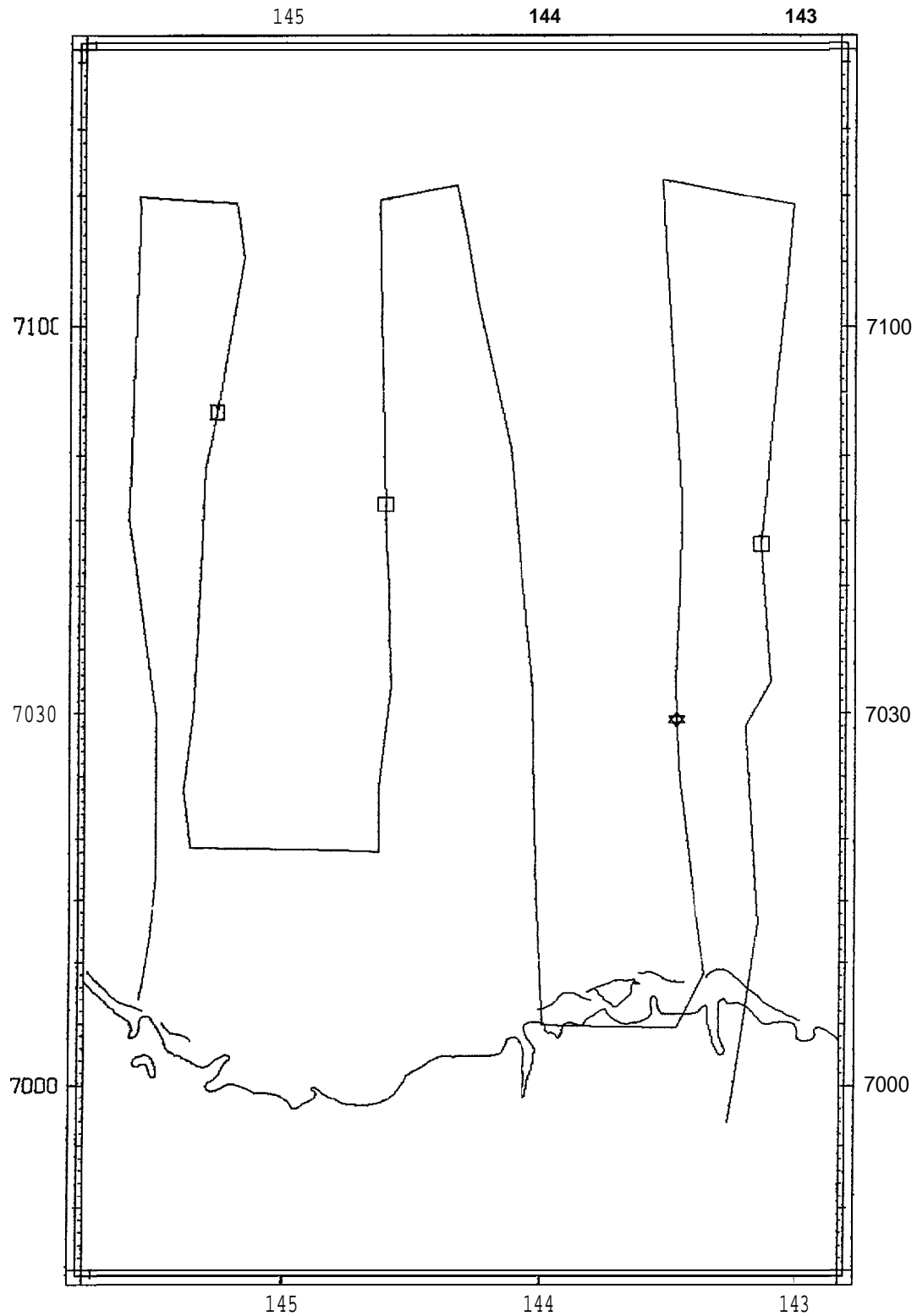
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/0	69°54.3'	140°06.2'	8726.1	BO	BR	150	1	1	55
1/0	69°59.2'	139°56.3'	545	BO	SS	360	3	0	59
1/0	70°01.0'	141°15.2'	2151.5	BO	DI	150	2	2	40
1/0	70°09.5'	141°22.8'	2593.6	BO	DI	150	1	2	49

KEY FOR FLIGHT 60

Flight #60, 7 September, 1982

✱ (BEARDED SEAL)

□ (UNKNOWN PINNIPED)



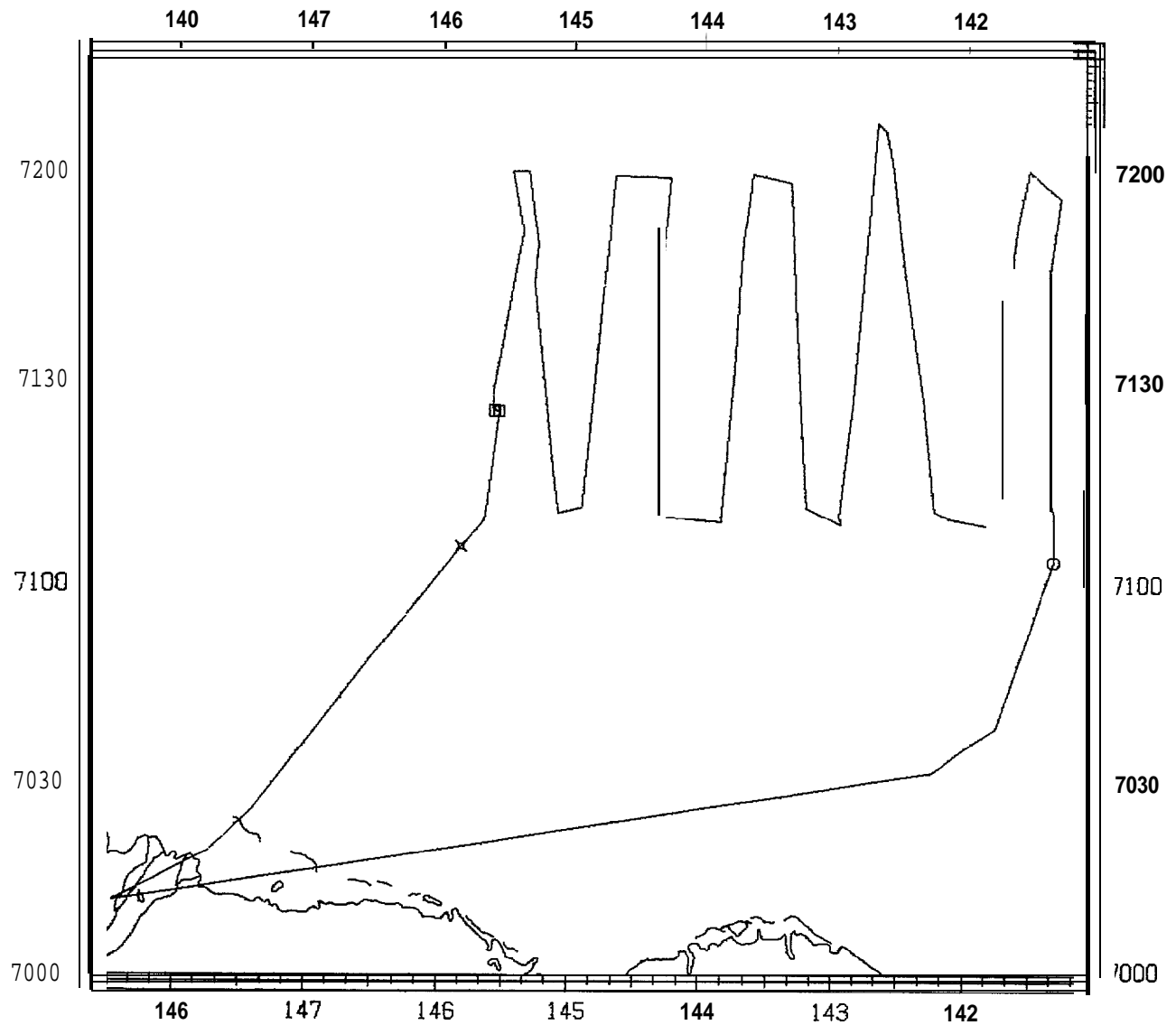
Flight #60, 7 September 1982

Flight was a transect survey of blocks 4 and 6. The weather ranged from a low ceiling to heavy fog, with a few snow squalls. Visibility was generally unacceptable. Sea state ranged from Beaufort 02 to 04. Ice coverage was 3/10 broken floe. Bearded seals and unidentified pinnipeds were the only marine mammals sighted.

KEY F(3R FLIGHT 61

Flight #61, 8 September, 1982

- (BOWHEAD WHALE)
- ✕ (RINGED SEAL)
- (POLAR BEAR)

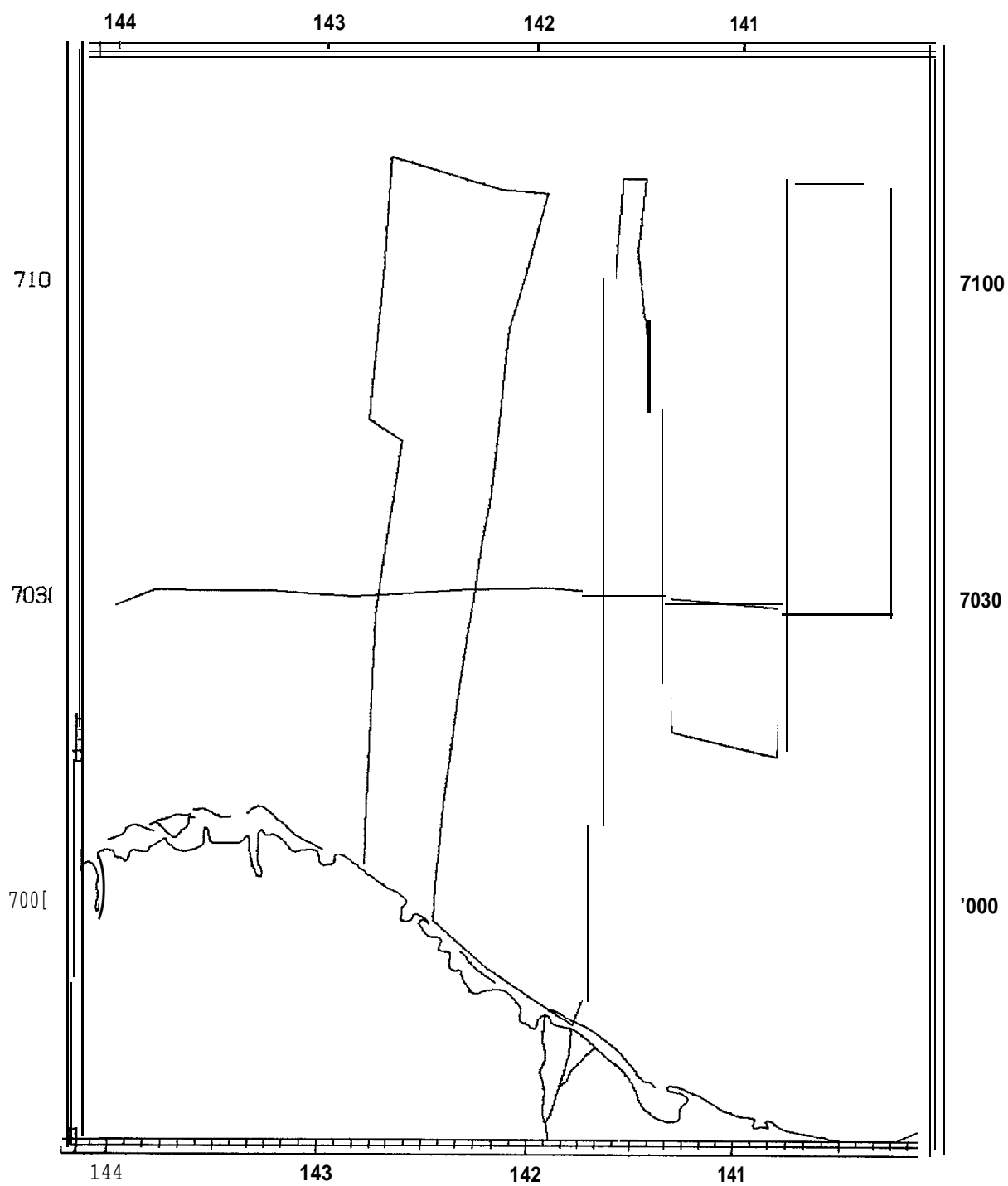


Flight #61, 8 September 1982

Flight was a transect survey of blocks 9 and 8. The weather ranged from unlimited to unacceptable. Sea state ranged from Beaufort 02 to 04. Ice coverage was 2/10 to 4/10 of broken floe. Four bowheads, including one cow/calf pair, a ringed seal and one polar bear were seen northwest of Barter Island. One **sonobuoy** was dropped during behavioral circling but only seismic sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/1	71°25.6'	145°33.3'	290.7	BO	CC	270	3	3	1829
2/0	71°25.7'	145°35.4'	88	BO	SW	240	3	3	1829

Flight #62, 11 September, 1982



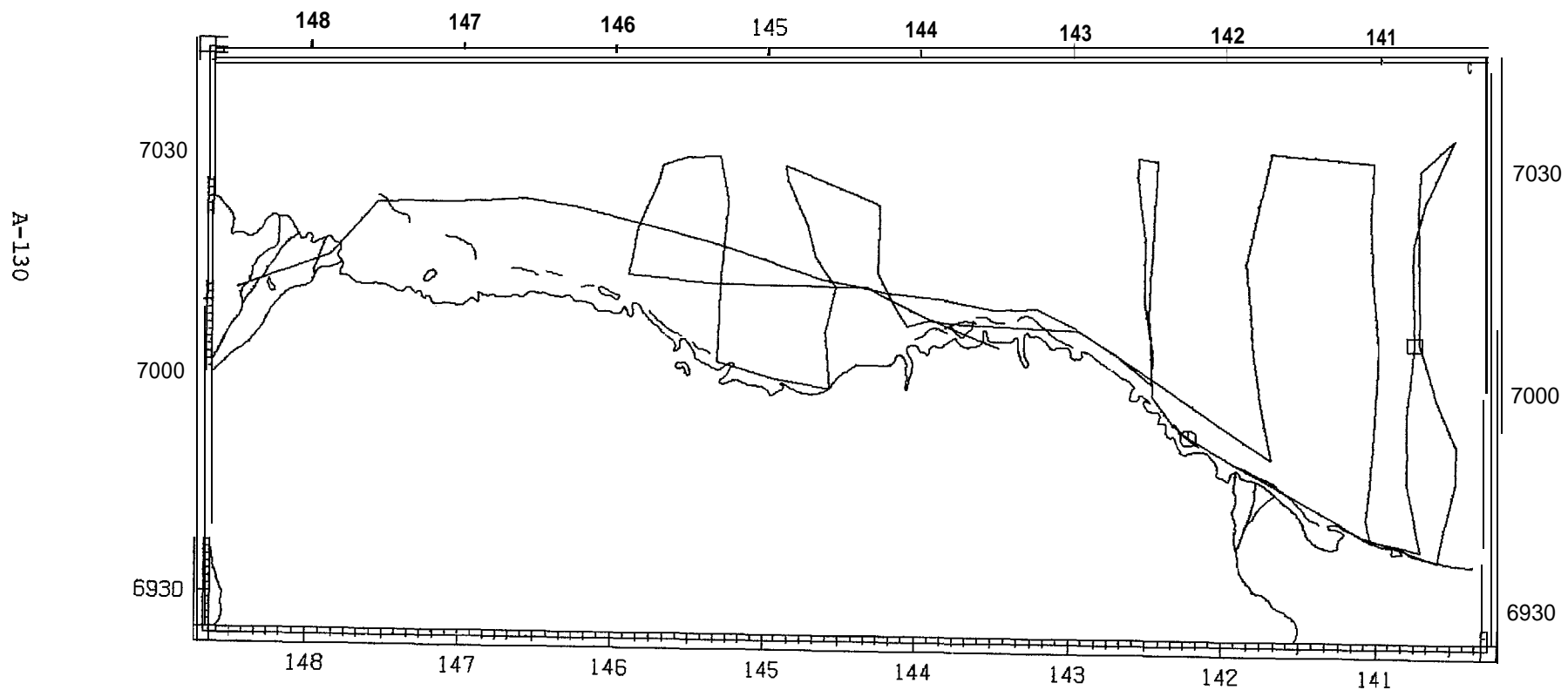
Flight #62, 11 September, 1962

Flight was a transect survey of block 7 and part of block 5. The weather ranged from partly cloudy to heavy fog. Visibility ranged from unlimited to unacceptable. Sea state ranged from Beaufort 03 to 06. Ice coverage was 0/10. No marine mammals were sighted. One **sonobuoy** was dropped, but no sounds were recorded.

KEY FOR FLIGHT 63

Flight #63, 14 September, 1982

□ (BOWHEAD WHALE)
○ (UNKNOWN PINNIPED)

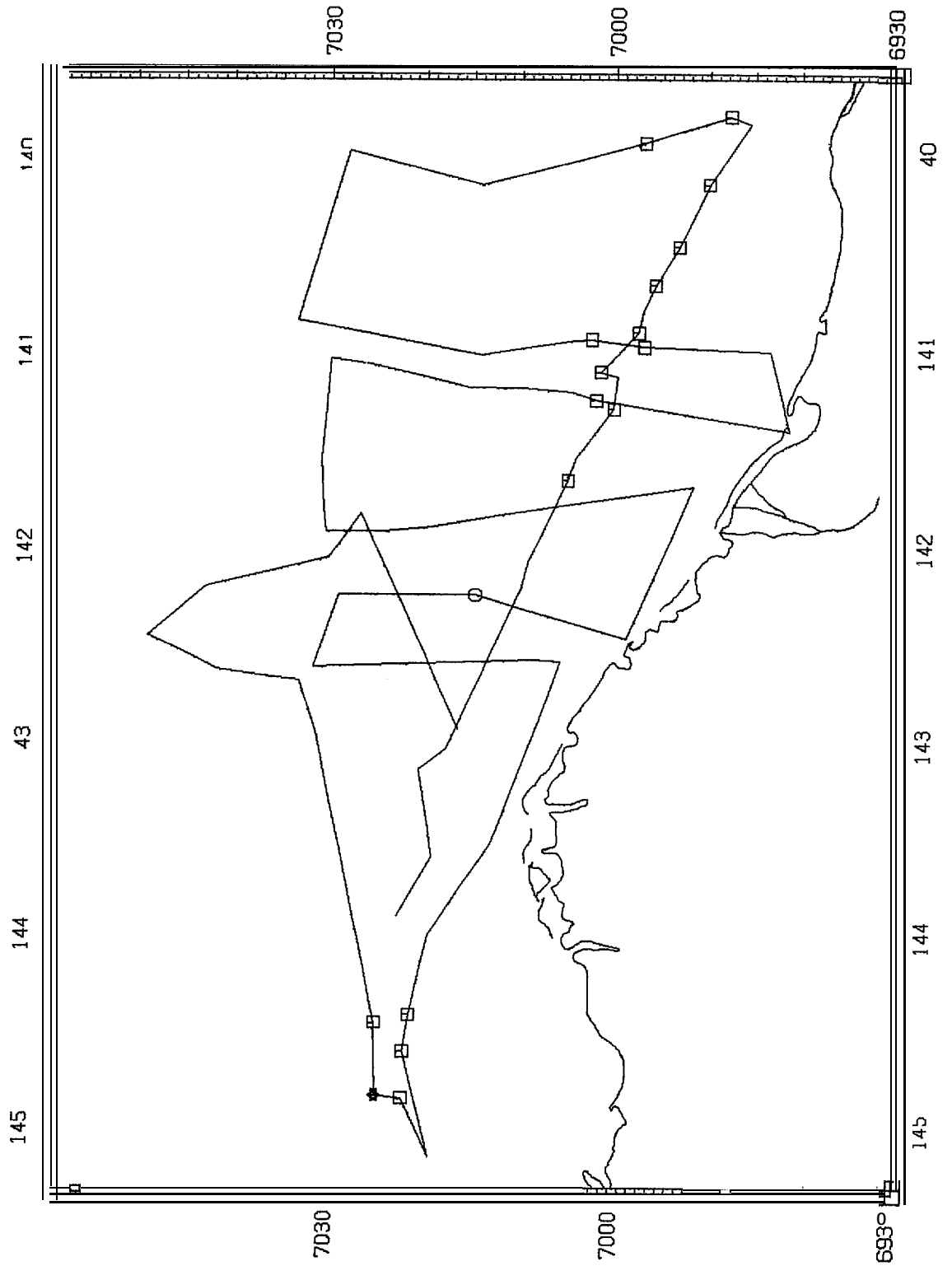


Flight #63, 14 September 1982

Flight was a transect survey of blocks 5 and 4. The weather ranged from a low ceiling to patchy fog. Visibility ranged from unlimited to unacceptable. Sea state ranged from Beaufort 00 to 04. Ice coverage was 0/10. One bowhead was sighted north of Demarcation Bay. One **sonobuoy** was dropped and whale sounds (probably **belukha**) were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	70°06.2'	140°45.5'	691.6	BO	SW	030	0	3	40

- ▣ (BOWHEAD WHALE)
- ✱ (BEARDED SEAL)
- ⊙ (UNKNOWN PINNIPED)



Flight #64, 15 September 1982

Flight was a transect survey of block 5. The weather was clear. Visibility ranged from unlimited to unacceptable. Sea state ranged from Beaufort 02 to 05. Ice coverage was 0/10. Forty-two bowheads, including three calves, and a bearded seal were sighted northeast of Barter Island. One **sonobuoy** was dropped and good bowhead whale sounds were recorded.

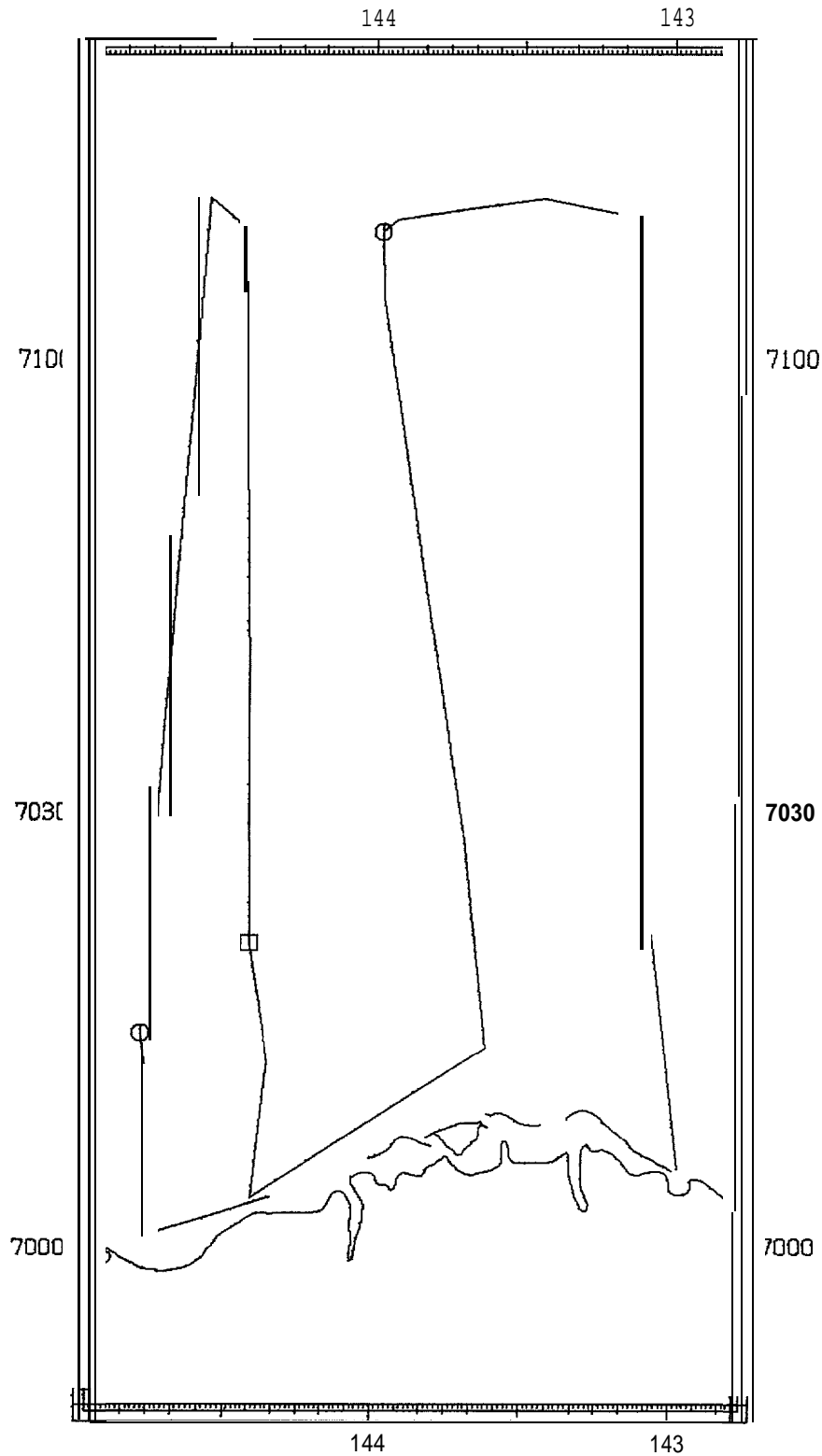
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH(M)
1/0	70°04.9'	141°39.6'	606.9	SP	Sw	030	0	2	37
3/0	70°00.1'	141°17.6'		BO	Sw	350	0	2	37
2/0	70°01.5'	141°06.3'	1131.9	BO	DI	270	0	2	37
2/0	69°57.5'	140°54.5'	545	BO	Sw	030	0	2	37
4/1	69°55.7'	140°39.9'	1056.1	BO	cc		0	2	37
1/0	69°53.2'	140°27.9'	1130	BO	Sw	210	0	2	37
7/1	69°50.0'	140°08.6'	7251.8	WD	GM	120	0	2	37
5/0	69°47.8'	139°47.4'	440.1	BO	TL	240	0	2	40
6/1	69°56.9'	139°55.6'	8711.9	WD	Sw	210	0	2	53
2/0	70°02.5'	140°56.6'	6539.9	BW	Sw		0	2	40
2/0	69°56.9'	140°58.7'	937.6	WD	DI		0	2	31
2/0	70°02.0'	141°14.9'	3254	WD	DI		0	2	40
2/0	70°21.3'	144°24.2'	6539.9	BW	Sw	030	0	2	37
1/0	70°21.9'	144°35.7'	585.3	BO	Sw	270	0	2	37
1/0	70°22.0'	144°50.1'	829.4	BO	DI	090	0	2	37
1/0	70°24.9'	144°26.8'	1328.1	BO	DI	120	0	2	42

KEY F(3R FLIGHT 65

Flight #65, 15 September, 1982

• 1 (BOWHEAD WHALE)

○ [UNKNOWN PINNIPED]



Flight #65, 15 September 1982

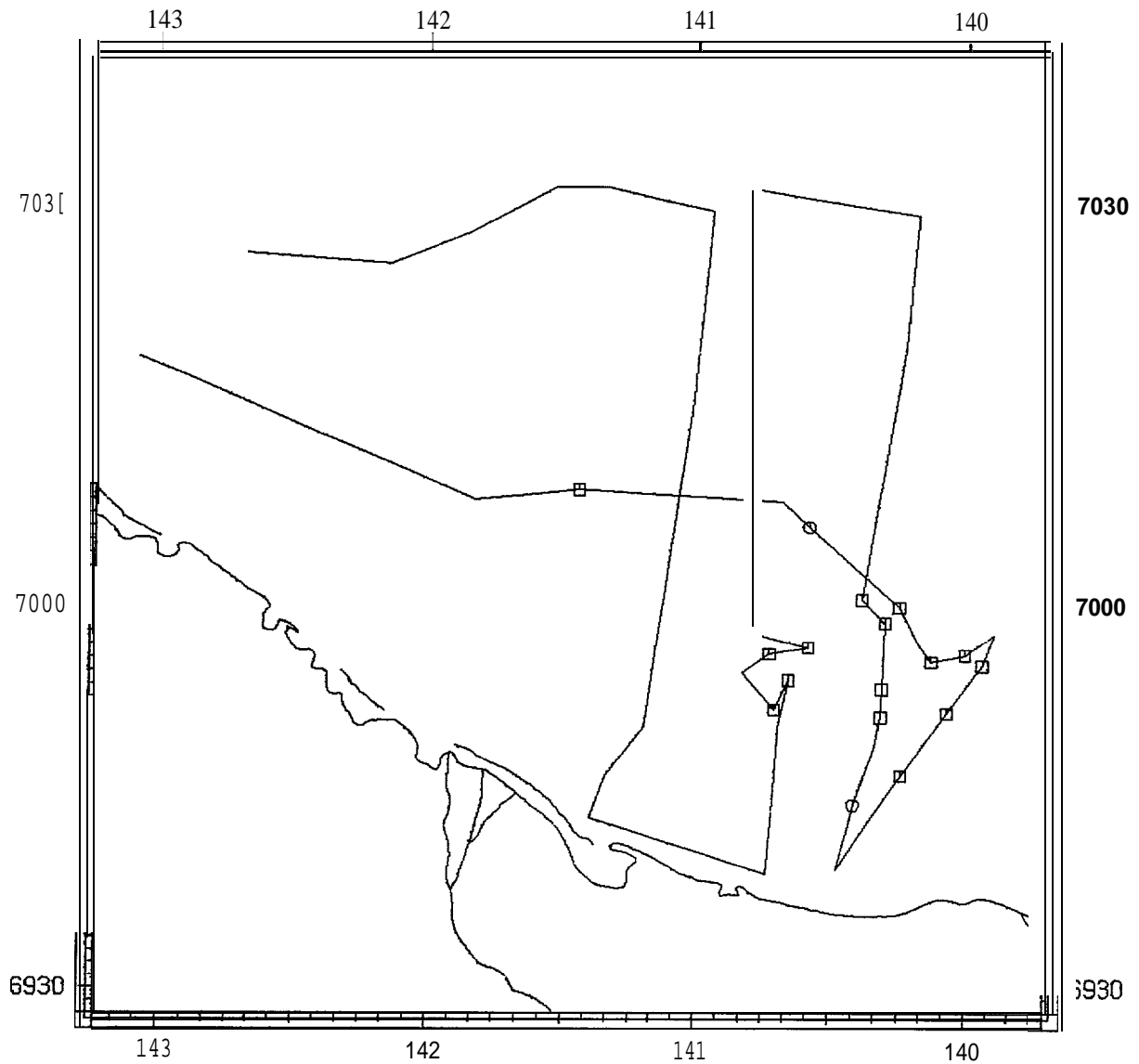
Flight was a transect survey of the eastern 2/3 of blocks 4 and 6. The weather ranged from partly cloudy to overcast. Visibility was unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage was 0/10. One bowhead was sighted north of Barter Island.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
1/0	70°21.1'	144°25.2'	1131.9	SP	DI	180	0	2	29

KEY FOR FLIGHT 66

Flight #66, 16 September, 1982

□ (BOWHEAD WHALE)
 ⊙ (UNKNOWN PINNIPED)



Flight #66, 16 September 1982

Flight was a **partial** transect survey of block 5. The weather ranged from partly cloudy to overcast. Visibility was unlimited. Sea state ranged from Beaufort 01 to 06. Ice coverage was 0/10. Sixty-one bowheads, including four calves, were sighted north of Demarcation Bay. One **sonobuoy** was dropped, but no whale sounds were recorded.

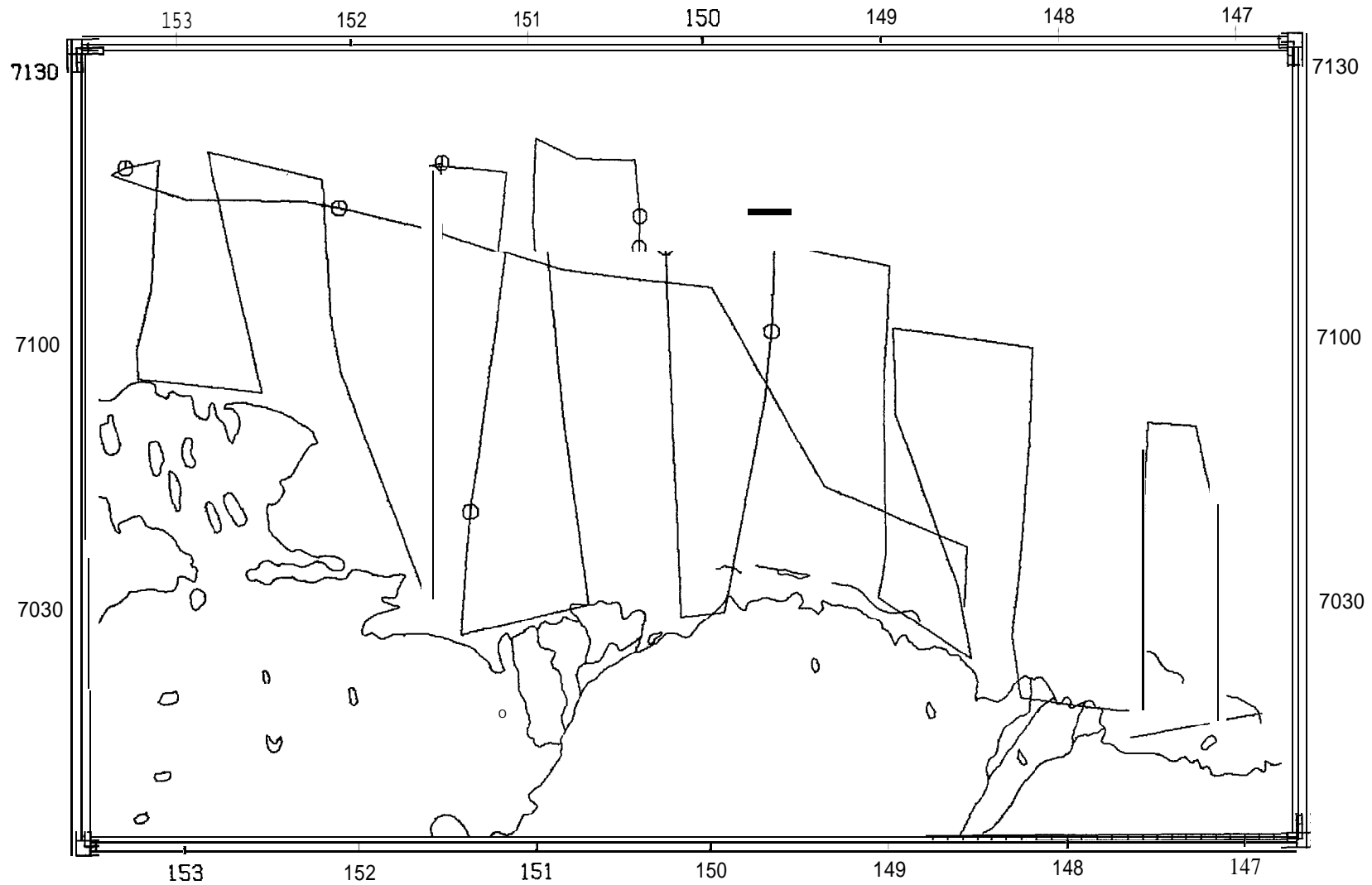
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	Ss	DEPTH (M)
1/0	70°08.7'	141°26.6'	2887.4	SP	DI	030	o	3	37
5/1	69°59.8'	140°14.9'	2151.5	WD	Sw	280	0	3	46
7/1	69°55.6'	140°07.8'	792.1	BO	GM		0	3	51
7/1	69°56.1'	140°00.1'	3254	WD	GM		0	3	53
6/0	69°55.3'	139°56.2'	320.2	BO	Sw	160	0	3	53
1 2/0	69°51.7'	140°04.2'	1407.5	BO	GM		0	3	29
1/0	69°46.8'	140°14.6'	585.3	BO	DI	330	0	3	33
1/0	69°51.4'	140°18.9'	4360	WD	DI		0	2	31
8/0	69°53.5'	140°18.6'	1434.3	BO	DI	210	0	2	31
1/0	69°58.6'	140°18.0'		NA	NA	330	0	2	33
1/0	70°00.4'	140°22.0'	718.2	BO	Sw	210	0	2	59
4/1	69°57.8'	140°46.7'	2900.7	WD	Sw	270	0	1	37
1/0	69°56.7'	140°34.8'		BO	Sw	270	0	1	42
3/0	69°56.2'	140°43.5'	3484.8	BO	Sw	230	0	1	40
2/0	69°52.0'	140°42.4'	837.6	WD	DI		0	2	38
1/0	69°54.2'	140°39.2'		BO	Sw		0	2	37

KEY FOR FLIGHT 67

Flight #67, 18 September, 1982

- (POLAR BEAR)
- (UNKNOWN PINNIPED)

A-138



Flight #67, 18 September 1982

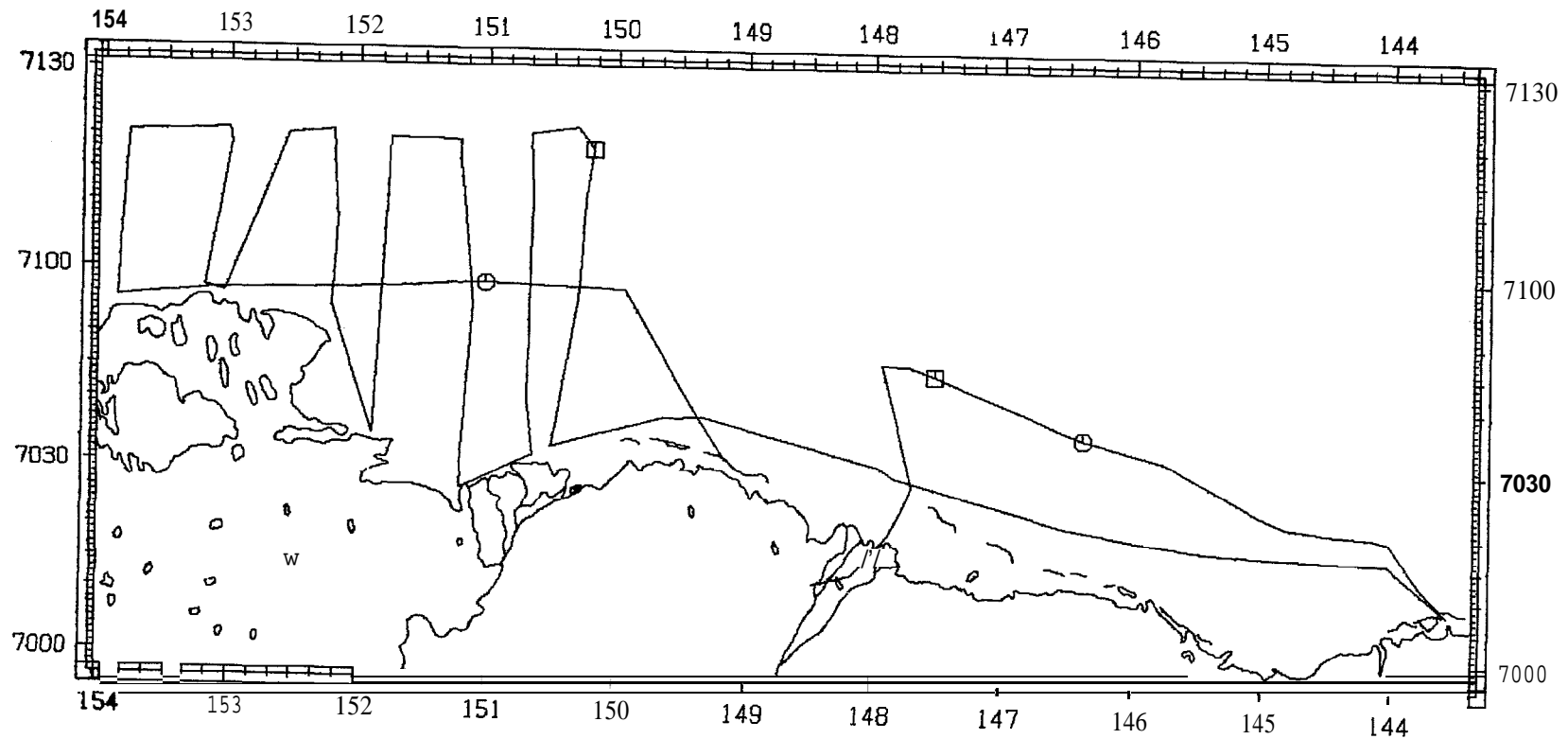
Flight was a transect survey of blocks 3 and 1. The weather ranged from overcast to a low ceiling. Visibility was generally unlimited. Sea state ranged from Beaufort 03 to 08. Ice coverage was 0/10. One polar bear was the only marine mammal sighted.

KEY FOR FLIGHT 68

Flight #68, 21 September, 1982

□ (BOWHEAD WHALE)
○ (UNKNOWN PINNIPED)

A-140



Flight #68, 21 September 1982

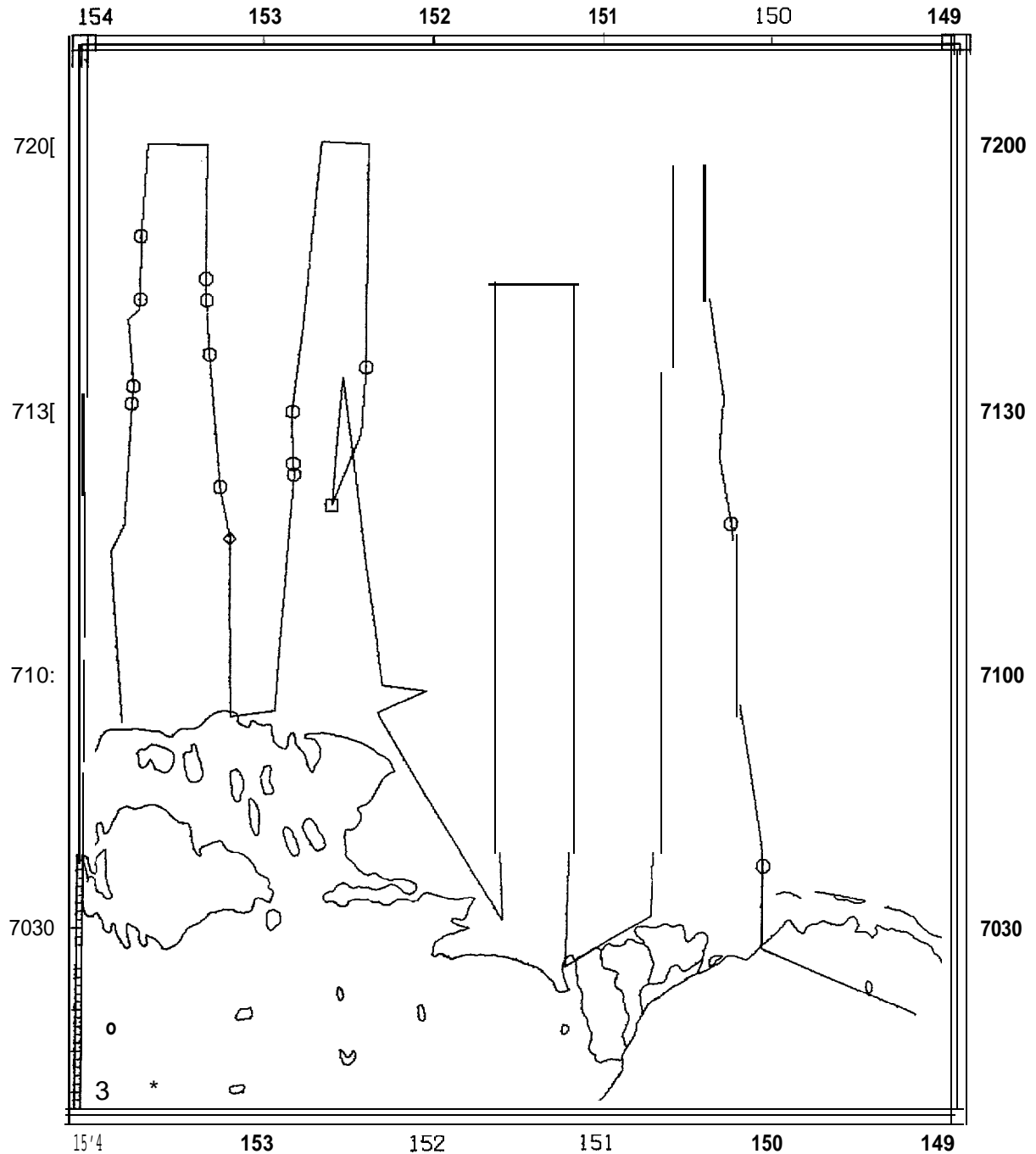
Flight was a transect survey of block 3 with a search survey through blocks, 1, 2, 4 and 6. The weather was a low ceiling condition. Visibility was generally 5 to 10 km. sea state ranged from Beaufort 06 to 08. Ice coverage was 0/10. Two bowheads were sighted. One **sonobuoy** was dropped but no sounds were recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH (M)
1/0	70°44.6'	147°31.3'	111	BO	SW	210	0	6	37
1/0	71°18.4'	150°11.5'	1434.3	BO	Sw	240	1	8	366

KEY FOR FLIGHT 69

Flight #69, 23 September, 1982

- (BOWHEAD WHALE)
- ◇ (WALRUS)
- (UNKNOWN PINNIPED)



Flight #69, 23 September 1982

Flight was a transect survey of blocks 3 and 11. The weather was calm and overcast. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage was 0/10. One dead or near dead (immobile and bloated) bowhead was sighted north of Harrison Bay. Many unidentified pinnipeds and one walrus were sighted near the 40 m depth contour. Three sonobuoys were dropped but **only** seismic sounds were recorded.

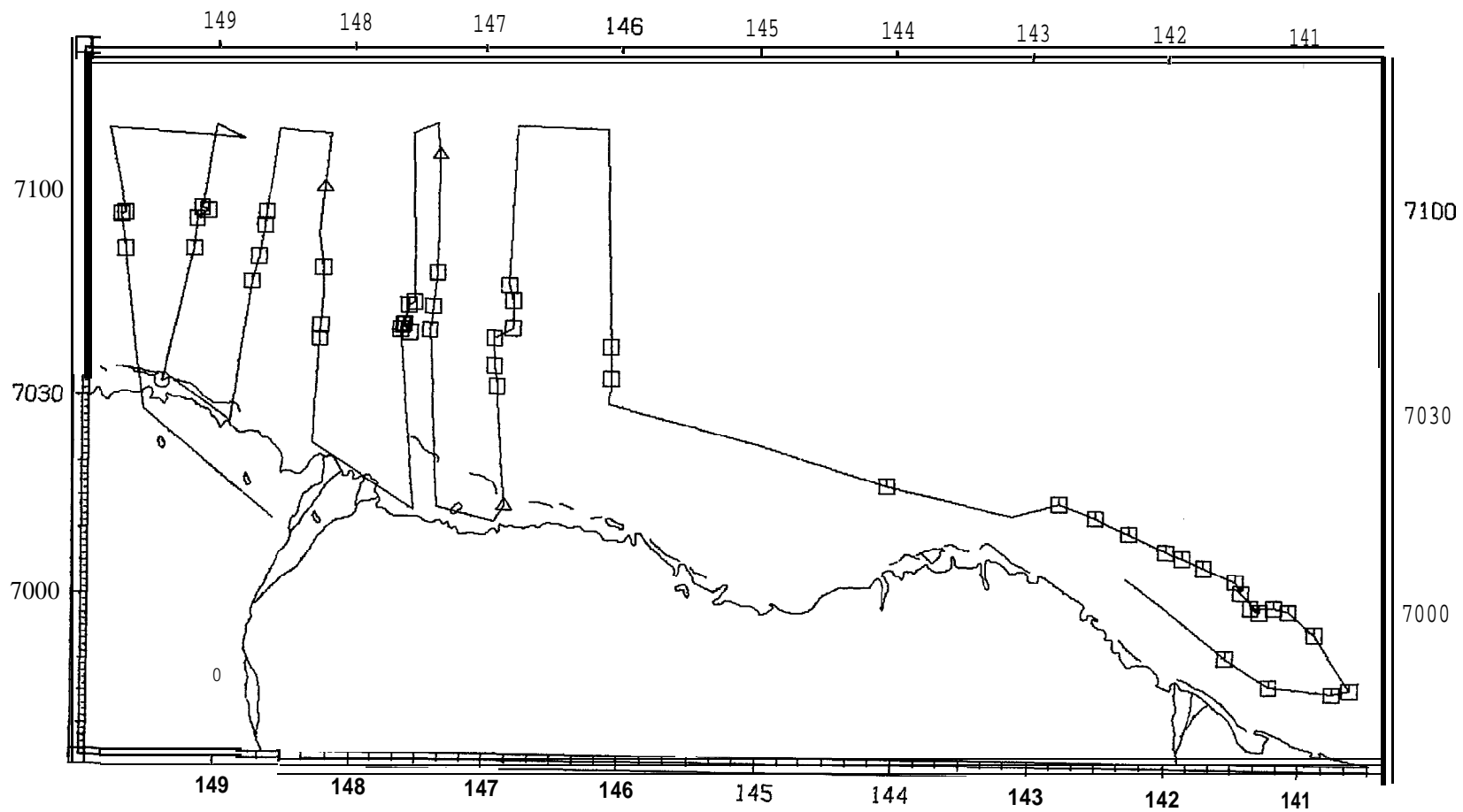
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°19.3'	152°36.0'		BO	DD		0	2	183

KEY FOR FLIGHT 70

- (BOWHEAD WHALE)
- (POLAR BEAR)
- △ (UNKNOWN PINNIPED)

Flight #70, 24 September, 1982

A-144



Flight #70, 24 September 1982

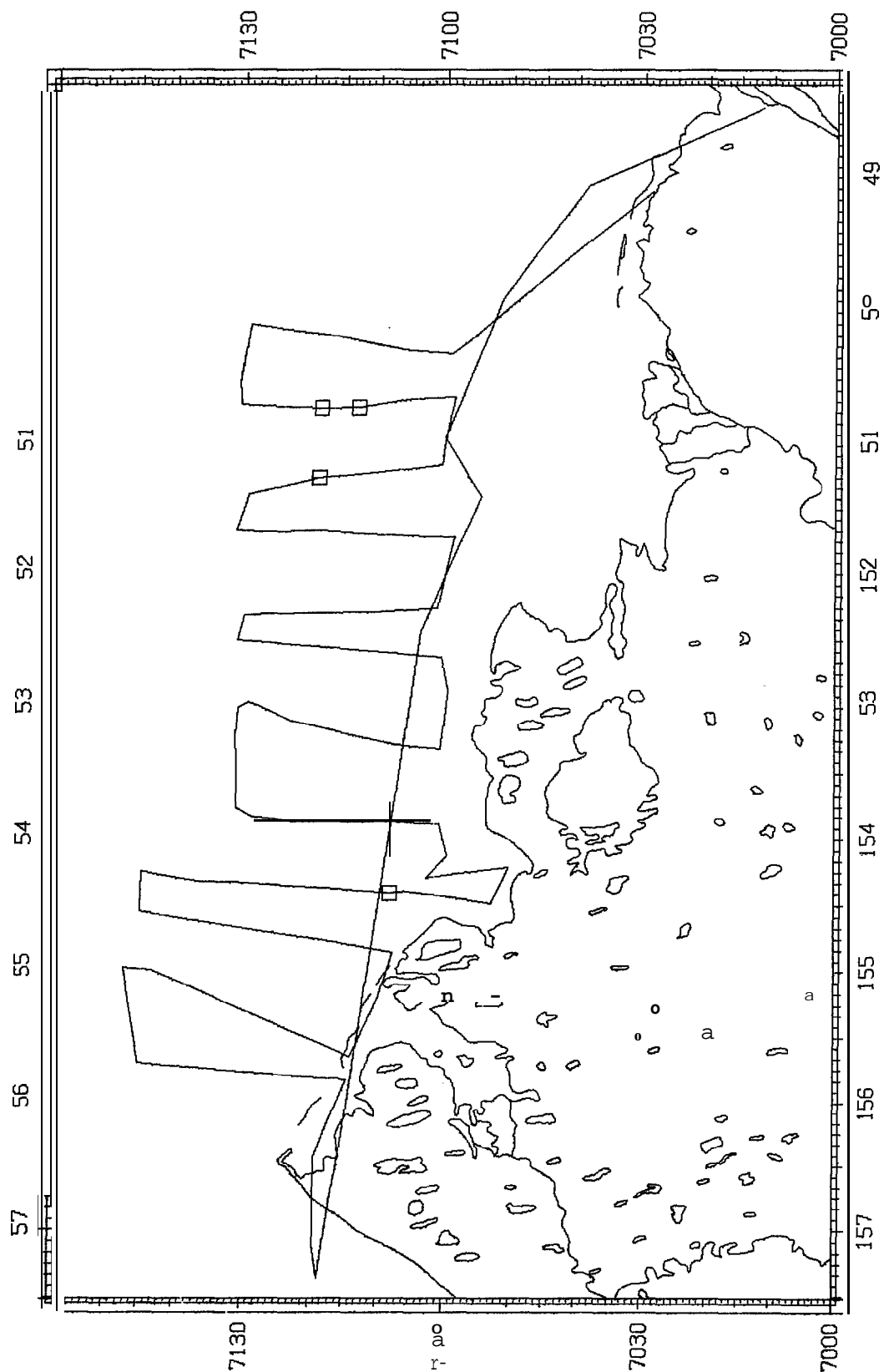
Flight was a transect survey of Blocks 1 and 2 then a search survey along the 30 m depth contour to Demarcation Bay. The weather was calm and overcast. Visibility was generally unlimited. Sea state ranged from Beaufort 00 to 02. Ice coverage was 0/10. One hundred fifty-nine bowheads, including three calves, and one polar bear were sighted north of Deadhorse and east of Barter Island. Three sonobuoys were dropped and bowhead sounds recorded.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	WDG	ICE	Ss	DEPTH(M)
14/2	70°51.81	149°42.41	2169.3	BO	SW	210	0	1	26
5/0	70°56.91	149°42.11	754.6	so	FB	120	0	1	20
2/0	70°57.1'	149°40.3'		BO	FE	240	0	1	20
1/0	70°58.0'	149°06.3'	2169.3	BO	DI		0	1	22
1/0	70°57.6'	149°03.6'		BO	SW		0	1	22
1/0	70°56.4'	149°08.6'	528.1	BO	SW	190	0	1	22
2/0	70°52.00	149°09.8'	2900.7	BO	FE		0	1	22
4/0	70°47.3'	148°44.0'	1063.2	BO	SW	330	0	1	26
1/0	70°50.9'	148°40.9'	1137.8	NA	NA		0	1	26
1/0	70°55.5'	148°38.5,		BO	Ss	300	0	1	29
3/0	70°57.5*	148°37.7'		BO	GM	300	0	1	24
1/0	70°49.5'	148°12.6'	684.8	BW	DI		0	1	37
1/0	70°41.0'	148°13.6'		BO	DI	210	0	1	22
1/0	70°39.0\$	148°13.81		BO	Ss	250	0	1	24
2/0	70°40.6'	147°38.01	754.6	BO	DI		0	1	37
4/0	70°41.2'	147°37.0'		BO	FE		0	1	29
1/0	70°40.1'	147°34.0'		BW	SW		0	1	37
5/0	70°41.41	147°36.4,	754.6	BO	GM		0	1	37
2/0	70°44.1'	147°34.6'	2900.7	NA			0	1	37
2/0	70°44.5'	147°32.0,		BO	RO		0	1	37
2/0	70°49.01	147°21.9'		BW	DI		0	1	41
1/0	70°44.0'	147°23.7*	1729	BO	Sw		0	1	38
4/0	70°44.0-	147°23.7,	3484.8	BO	SW		0	1	48
1/0	70°40.5'	147°25.00		BO	SS		0	1	38
1/0	70°32.2*	146°54.6,	528.1	BO	Sw	330	0	1	38
1/0	70°35.2*	146°55.8,	8730.6	BO	SS		0	1	48
3/0	70°39.3'	146°55.9,		BO	SW		0	1	40
1/0	70°40.8'	146°47.7s	1063.2	BO	FE		0	1	40
2/1	70°44.91	146°47.61	111	BO	Ss		0	1	51
3/0	70°47.2'	146°49.61	81.7	BO	Sw		0	1	51
2/0	70°38.21	146°04.31	2169.3	BW	GM		0	1	40
1/0	70°33.5'	146°04.1-	3484.8	BO	Sw		0	1	38
1/0	70°17.9'	144°02.6,	754.6	Bw	SW		0	1	38
3/0	70°15.61	142°46.80	1434.3	BO	GM	030	0	1	37
1/0	70°13.5,	142°30.2,	142.2	BO	FE	150	0	1	54
3/0	70°11.2'	142°15.3,	754.6	BO	GM	240	0	1	38
4/0	70°08.5(141°59.6,	2169.3	BO	SH		0	1	46
1/0	70°07.6,	141°52.21		BO	SW	240	0	1	42
1/0	70°06.2'	141°42.8'	885.4	BO	FE		0	1	40
5/0	70°04.1,	141°28.6,	754.6	BO	TL		0	1	35
8/0	70°02.48	141°26.1,		BO	SW	220	0	1	31
7/0	69°59.5'	141°17.9,		BO	RO		0	1	40
1/0	70°00.21	141°21.7'		SP	RO		0	1	31
2/0	70°02.4,	141°11.5,		BO	Sw	360	0	1	31
5/0	69°59.61	141°05.0'	2603.2	BO	Sw		0	1	31
3/0	69°56.2"	140°53.3'	2820.1	Bo	GM		0	1	33
1/0	69°47.7-	140°38.0S	2900.7	BO	Sw	240	0	1	29
8/0	69°47.1'	140°45.68		BO	FE	210	0	1	26
1/0	69°48.0'	141°13.4,	885.4	BO	FE		0	1	27
1/0	69°52.31	141°32.8,		Bo	SS		0	1	31

KEY FOR FLIGHT 71

Flight #71, 25 September, 1982

□ (UNKNOWN PINNIPED)



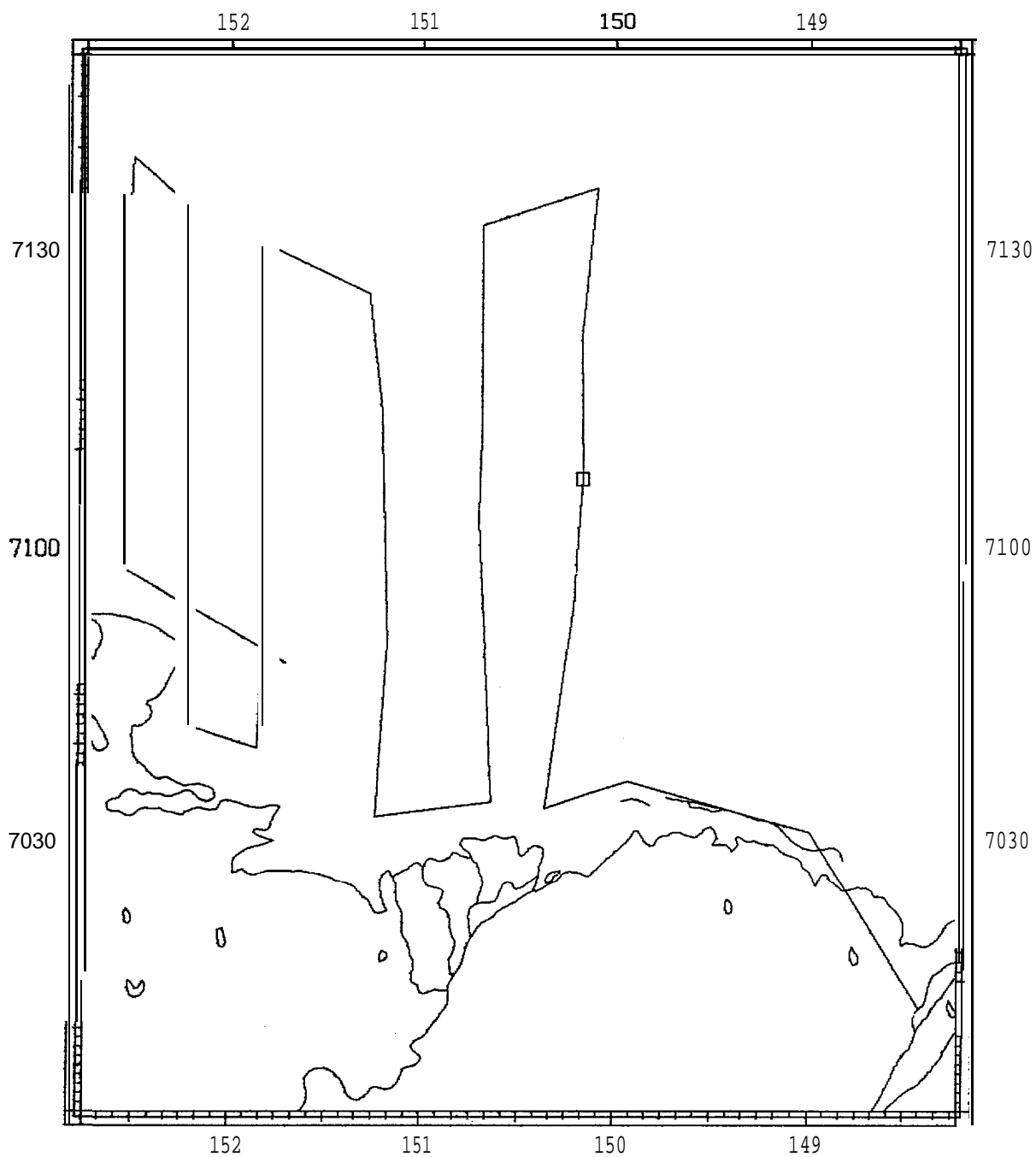
Flight #71, 25 September 1982

Flight **was a transect** survey of block 3 and **part** of block 12. The weather was calm with fog. Visibility was generally less than 3 km. Sea state ranged from Beaufort 00 to 02. Ice coverage was 0/10 except for 10 km of new shore fast ice east of Pt. Barrow. Seven unidentified pinnipeds were the only marine mammals sighted. One **sonobuoy** was dropped near Smith Bay to monitor seismic vessels.

KEY FOR FLIGHT 72

Flight #72, 27 September, 1982

□ (BOWHEAD WHALE)



Flight #72, 27 September 1982

Flight was a line transect survey the eastern 3/4 of of blocks 3 and 11, to 71°40'N latitude. Weather was calm, and overcast with patches of fog. Visibility ranged from unlimited to 2 km. Sea state was Beaufort 02 to 03. Two bowheads were sighted in Harrison Bay. One sonobuoy was dropped. No whale sounds were heard; distant seismic sounds were recorded.

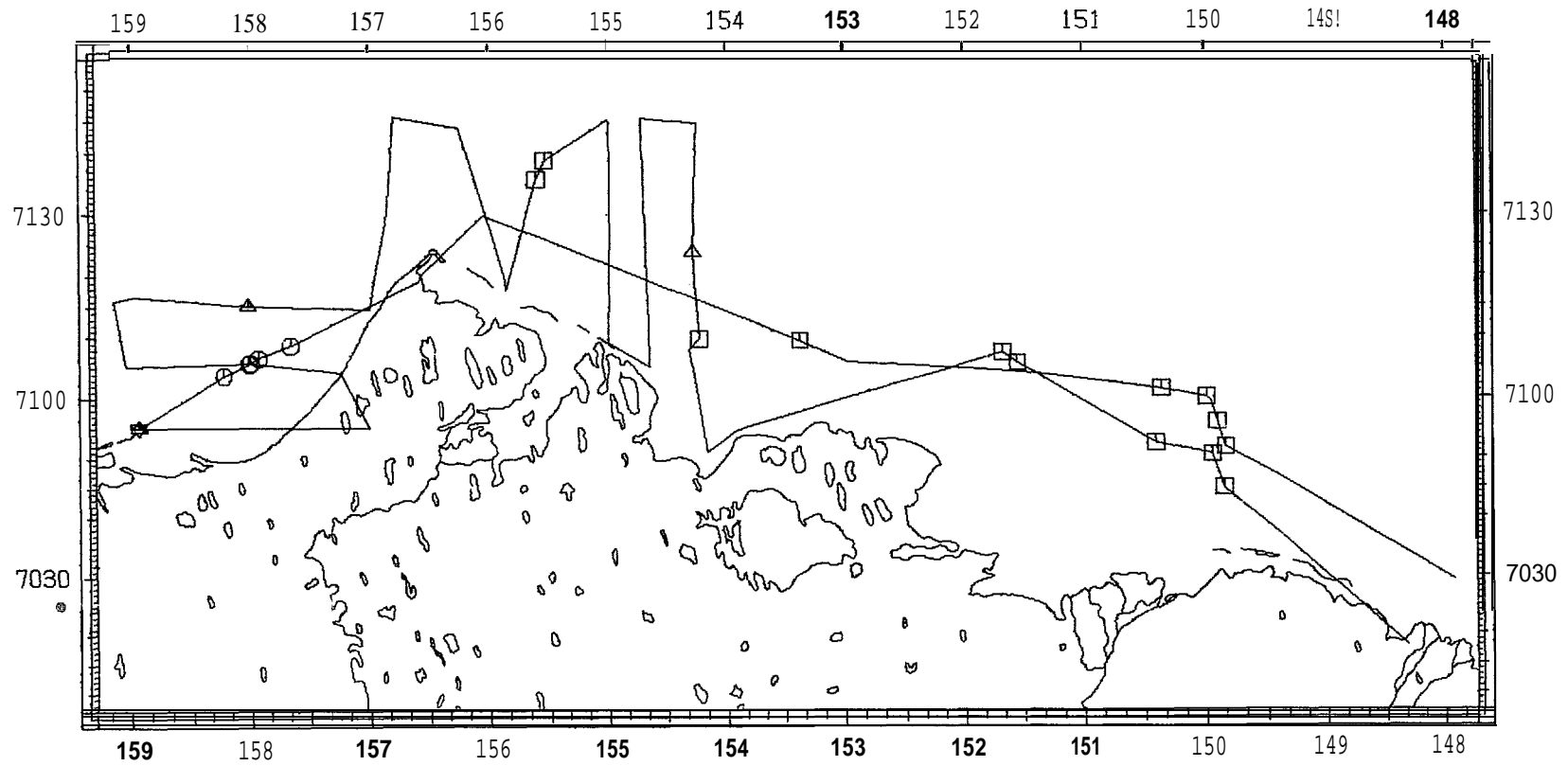
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/0	71°06.9'	150010.0'	176	BO	SW	240	0	2	27

KEY FOR FLIGHT 73

- (BOWHEAD WHALE)
- (GRAY WHALE)
- ★ (BEARDED SEAL)
- A (UNKNOWN PINNIPED)

Flight #73, 28 September, 1982

A-150



Flight #73, 28 September 1982

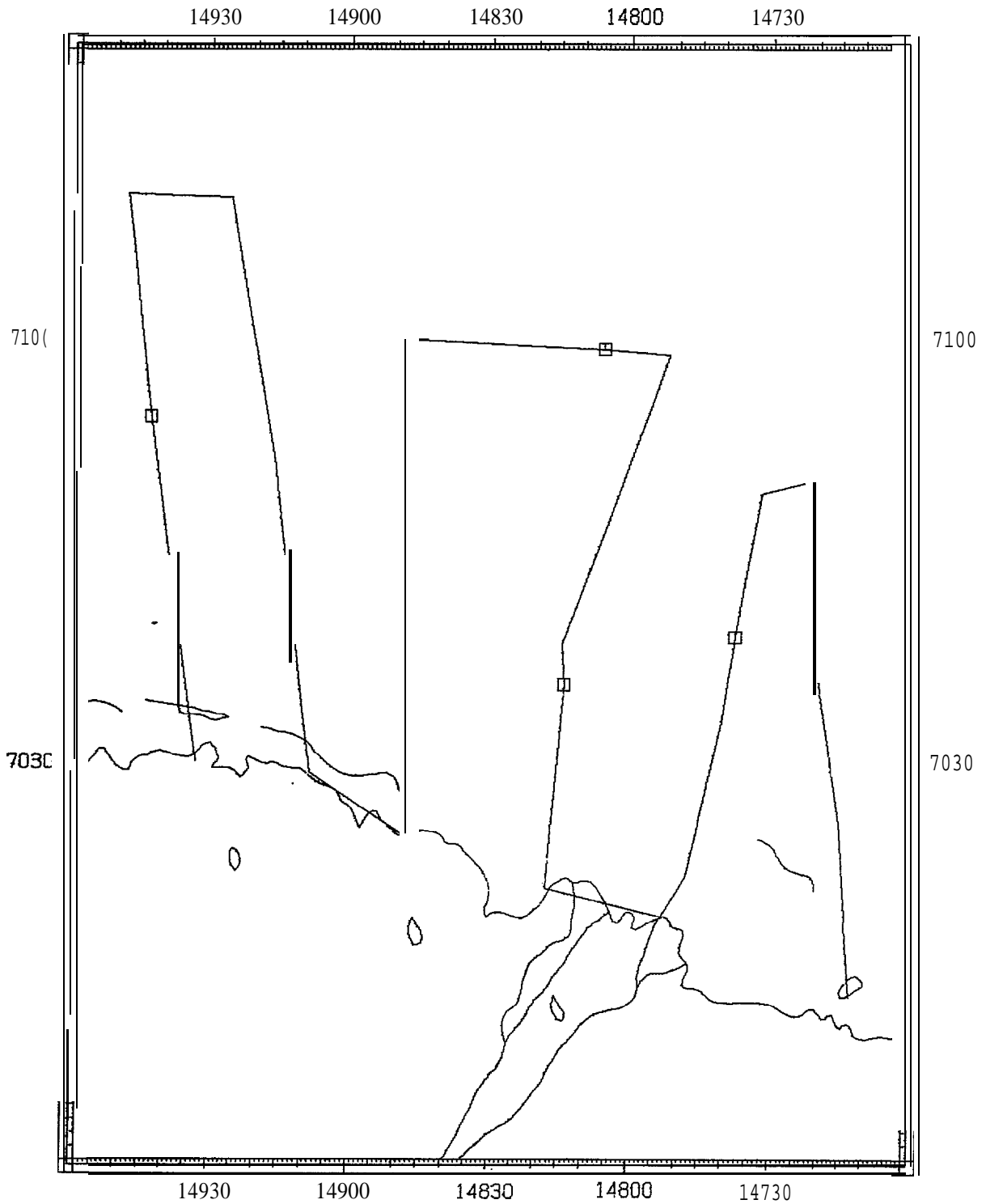
Flight was a search survey along the 20 m contour to block 12, a line transect survey of block 12 and 3 transect lines in the northern end of block M. Weather was overcast, visibility unlimited. Sea state ranged from 02 to 05. Ice coverage was 0/10. Fourteen live and one dead bowhead were sighted in Harrison Bay and north of Smith Bay. Eighteen gray whales were sighted in the **Chukchi** Sea. One **sonobuoy** was dropped. Seismic sounds and engine sounds of the coast guard icebreaker Polar Star were recorded,

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	70°44.9'	149°51.2'	225.8	BO	SS	180	o	2	15
2/0	70°50.5'	149°57.1'	1137.8	BO	SW	210	0	2	13
1/0	70°52.4'	150°25.0'		BO	Sw	210	0	2	13
1/0	71°05.7'	151°33.3'		WD	DI	270	0	2	18
1/0	71°07.4'	151°40.8'		WD	SS	206	0	2	18
1/0	71°09.6'	154°13.9'	653.8	DD	NA		0	4	183
1/0	71°38.6'	155°32.7'	528.1	WD	Ss	330	0	4	20
1/0	71°35.6'	155°36.8'	469.5	WD	SS	320	0	4	162
1/0	71°09.4'	153°22.6'	2900.7	BW	DI		0	4	16
1/0	71°01.4'	150°22.2'	1320.6	SP	DI	240	0	3	16
1/0	71°00.0'	150°00.0'	938.3	WD	DI	250	0	3	22
1/0	70°55.9'	149°54.5'	435.4	BO	SS	270	0	3	20
2/0	70°51 .7'	149°50.5'		BO	SW	270	0	3	18

KEY FOR FLIGHT 74

Flight #74, 29 September, 1982

• (BOWHEAD M-FILE)



Flight #74, 29 September 1982

Flight was a line transect survey of the western 3/4 of block 1. Weather was low overcast with patches of heavy fog. Visibility ranged from unlimited to less than 1 km. Sea state ranged from Beaufort 05 to 07. Ice coverage was 0/10. Five bowheads were sighted north of Deadhorse.

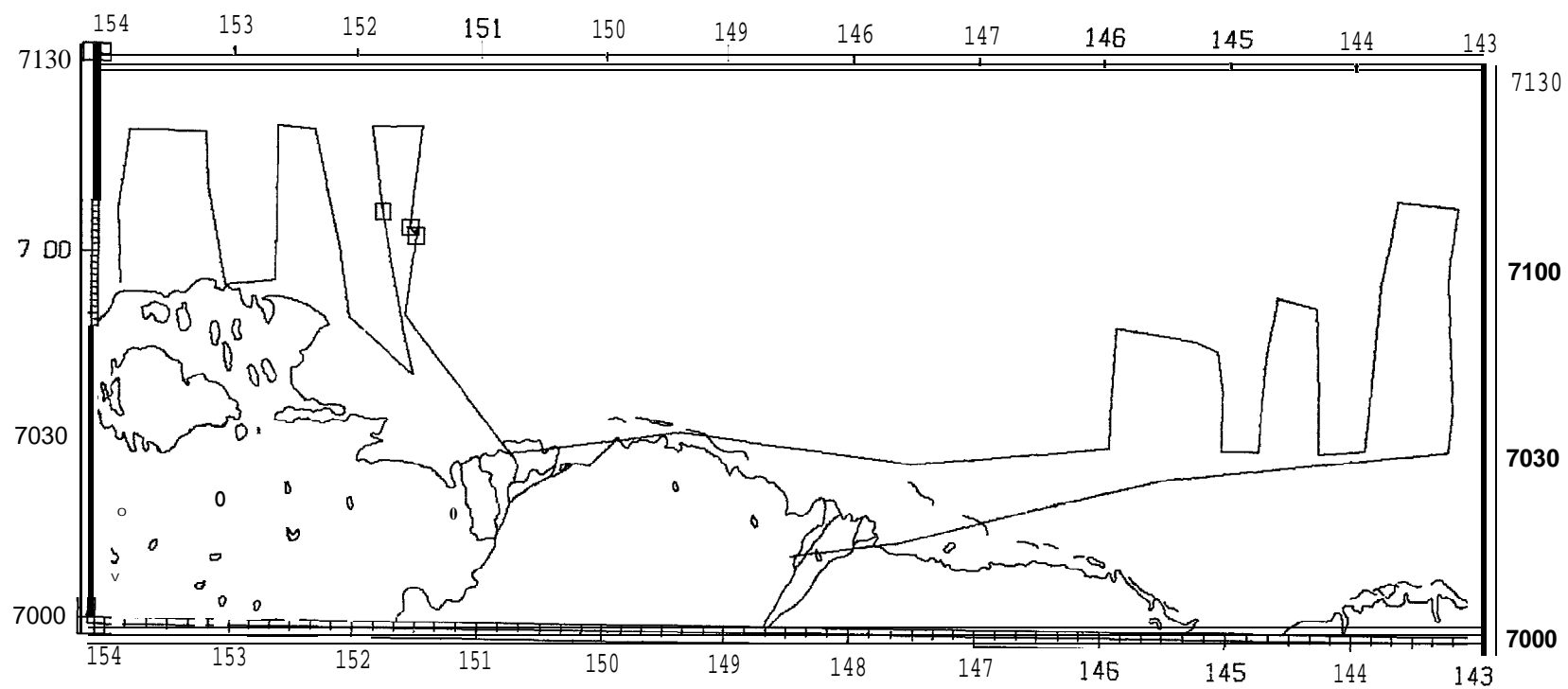
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/0	70°54.6'	149°42.9'	1434.3	BO	SW	210	0	5	15
1/0	70°59.2'	148°05.8'		BW	Sw		0	5	22
1/0	70°35.6'	148°14.0'	255.9	BO	SW	210	0	5	26
1/0	70°39.0'	147°37.5'	568.9	BO	SW		0	6	38

KEY FOR FLIGHT 75

Flight #75, 30 September, 1982

•1 (BOWHEAD WHALE)

A-154



Flight #75, 30 September 1982

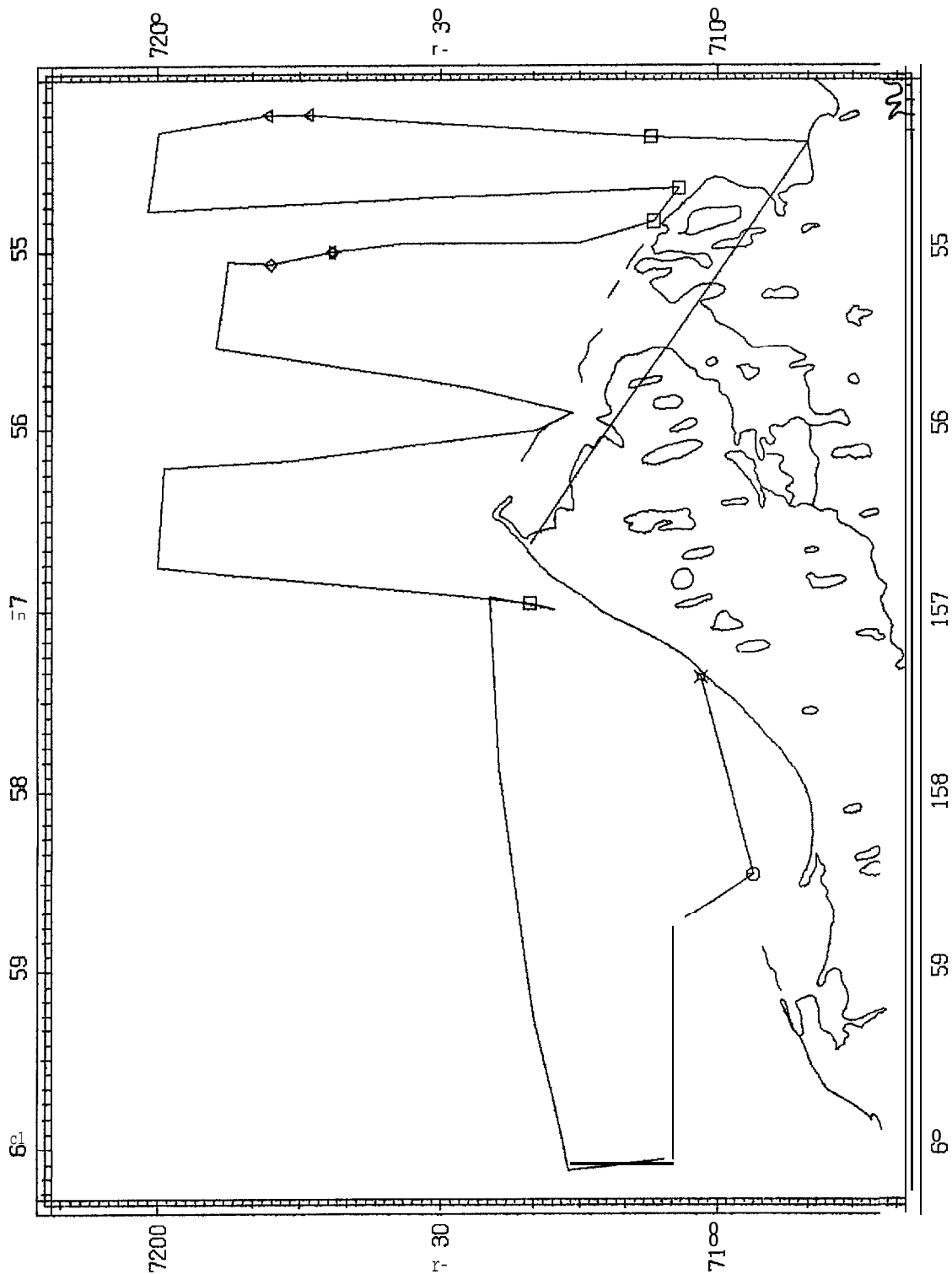
Flight **was a line** transect **survey of** block **6** and the western 2/3 of block 3. Weather ranged from overcast to heavy fog **which** caused the northern end of legs **in** block 6 and the eastern legs of block 3 to be aborted. **Visibility** ranged from unlimited to less **than 1 km.** Sea state ranged from **Beaufort 03 to** 08. Ice coverage ranged from 0/10 to 2/10 broken floe **ice.** Four bowheads were sighted north of **Smith** Bay.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°03.1'	151°30.8'	435.4	BO	SW	270	0	3	16
1/0	71°04.4'	151°33.7'	326.9	BO	SW	060	0	3	18
1/0	71°04.4'	151°33.7'	507.4	BO	SW	030	0	3	18
1/0	71°06.8'	151°47.2'	418.8	BO	SW	300	0	8	18

KEY FOR FLIGHT 76

- (BOWHEAD WHALE)
- ◇ (GRAY WHALE)
- △ (BELUGA WHALE)
- ★ (BEARDED SEAL)
- ◇ (WALRUS)
- ✕ (UNKNOWN CETACEAN)

Flight #76, 2 October, 1982



Flight #76, 2 October 1982

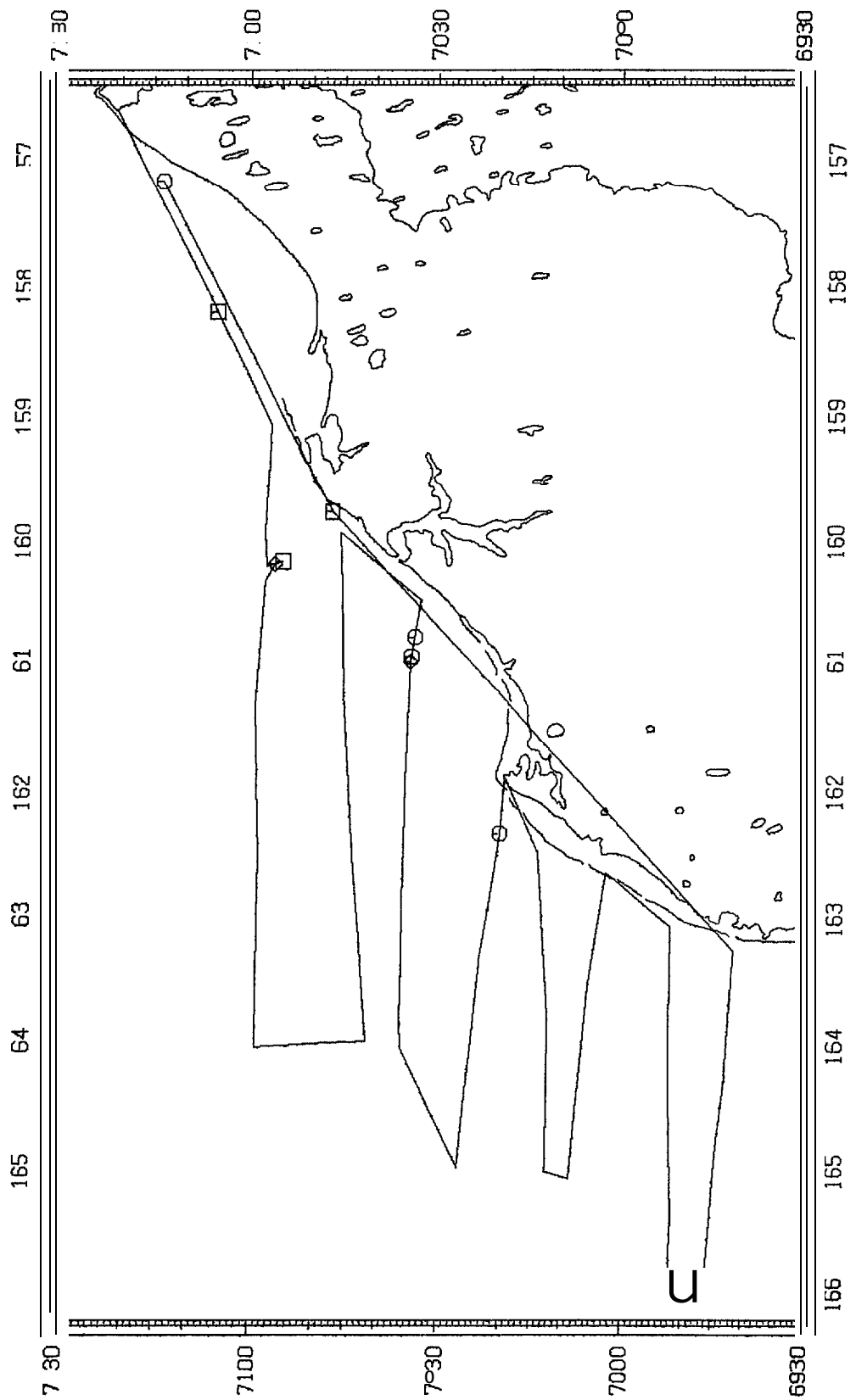
Flight was a line transect survey of block 12 and 2 lines in block M, Weather was overcast with patches of fog. Visibility ranged from unlimited to less than 1 km. Sea state ranged from Beaufort 01 to 04. Ice coverage ranged from 0/10" to 8/10 grease ice. Seven bowheads, two gray whales, belukhas, walrus, bearded seals and an unidentified cetacean were seen.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/0	71°07.3'	154°22.4'	684.8	BO	SW	260	5	0	9
2/0	71°04.2'	154°39.0'		BO	Sw	290	0	3	11
2/0	71°50.0'	154°24.0'	598.4	BO	SW	240	0	3	146
1/0	71°20.4'	156°57.5'	390.2	BO	SW	190	0	4	55

KEY FOR FLIGHT 77

- (BOWHEAD WHALE)
- (GRAY WHALE)
- ◇ (WALRUS)

Flight #77, 3 October, 1982



Flight #77, 3 October 1983

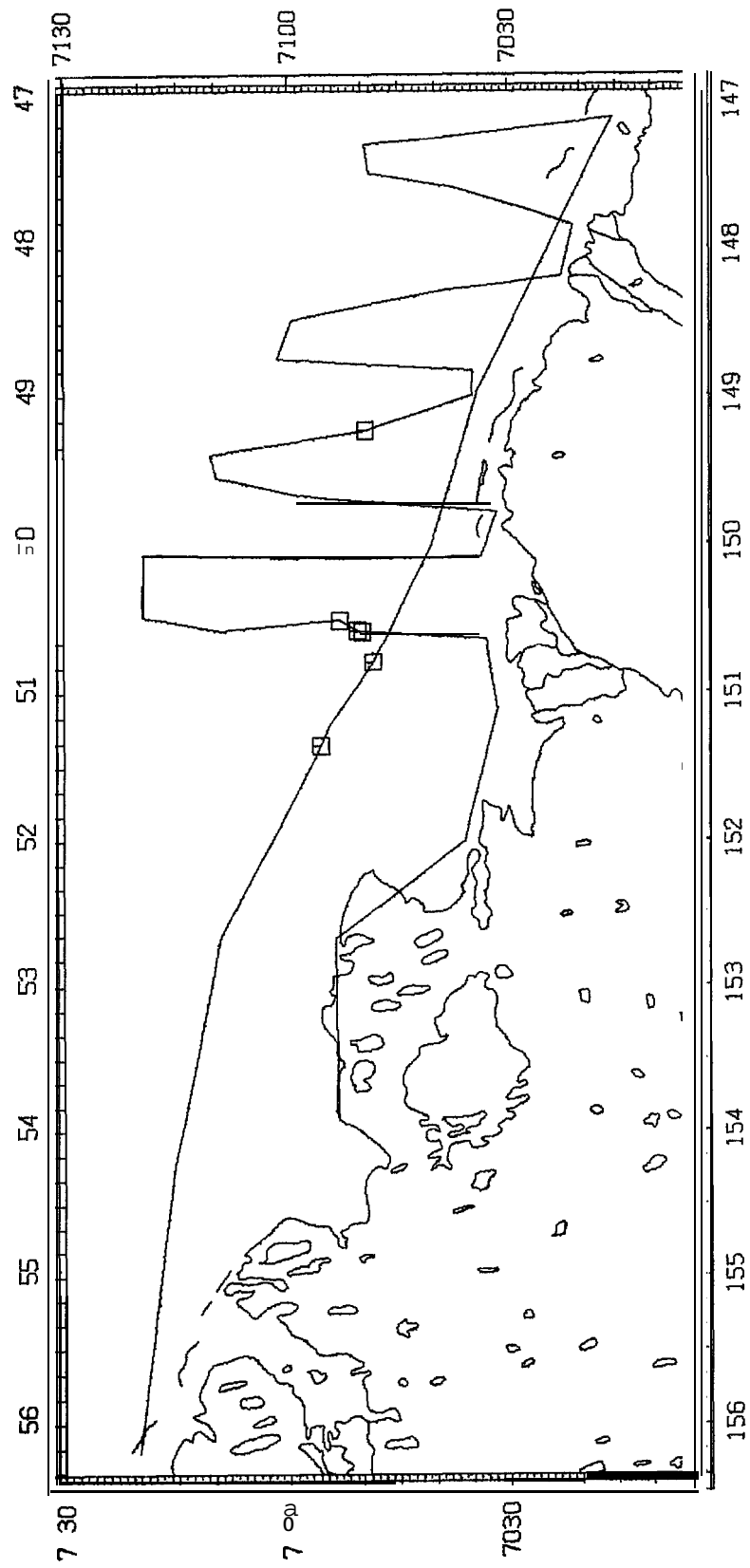
Flight was a **line** transect survey of block M. Weather was overcast with patches of fog. Visibility ranged from unlimited to 2 km. Sea state ranged from Beaufort 02 to 05. Ice coverage was 0/10. **Twolive** and one dead **bow-**head, four gray whales and two walrus were sighted north of **Wainwright**.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°05.1'	158°11.8'		BO	SW	170	0	5	37
1/0	70°54.6'	160°09.7'		OS	DD		0	3	10
1/0	70°46.8'	159°46.2'		BO	BR	210	0	3	29

KEY FOR FLIGHT 78

☐ (BOWHEAD WHALE)

Flight #78, 4 October, 1982



Flight #78, 4 October 1982

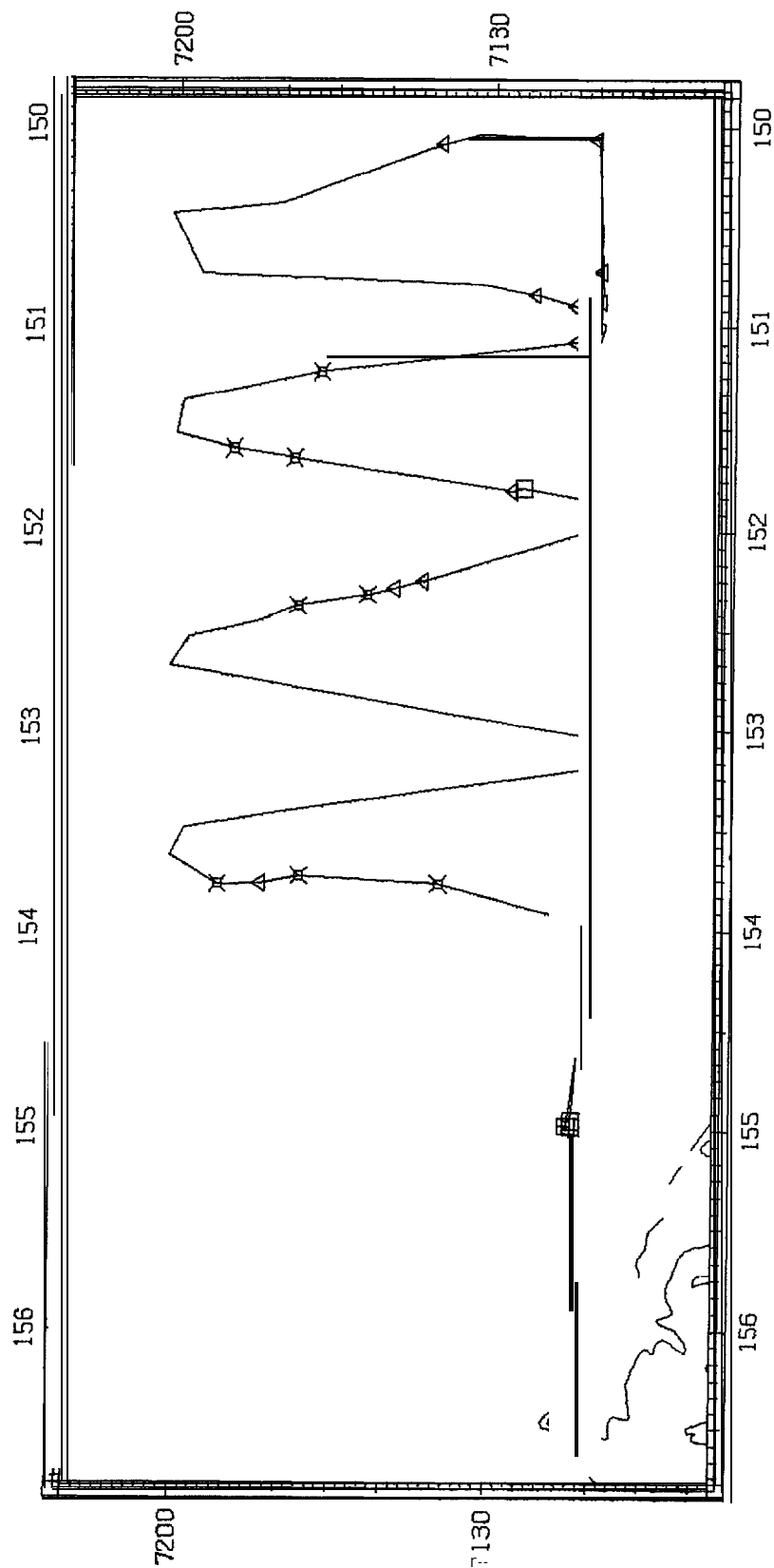
Flight was a line transect survey of the eastern 2 legs of block 3 and block 1 with a search survey along the 20-m contour from Deadhorse to Pt. Barrow. Weather was low overcast with heavy fog. Visibility ranged from **unlimited** to less than 1 km. Ice coverage in Smith Bay and Harrison Bay was **9/10**. Ice coverage ranged from 7/10 to 8/10 north of Harrison Bay, but dropped to less than 1/10 by **147°30'W** longitude. Sea State was Beaufort 05 to 06. Ten bowheads, including one calf, were sighted north of Deadhorse. Two bowheads that were sighted on the 20-m search survey were possible resights.

T#/C#	LAT(N)	LONG(W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
2/0	70°50.1'	150°35.0'	221.8	BO	SW	240	8	0	13
2/1	70°50.1'	150°35.0'	147.3	BO	CC	360	8	0	13
2/0	70°50.7'	150°34.7'	182.1	WD	SW	180	8	0	13
1/0	70°53.1'	150°30.7'	402.1	SP	DI	60	8	0	13
1/0	70°49.5'	149°13.8'	247.2	BO	SW	310	7	2	22
1/0	70°48.5'	150°47.5'	646.4	BO	SW	40	0	5	9
1/0	70°55.6'	151°21.3'	586.4	BO	SW	250	0	5	11

KEY FOR FLIGHT 79

- (BOWHEAD WHALE)
- ▲ (BELUGA WHALE)
- × RINGED SEAL

Flight #79, 5 October, 1982

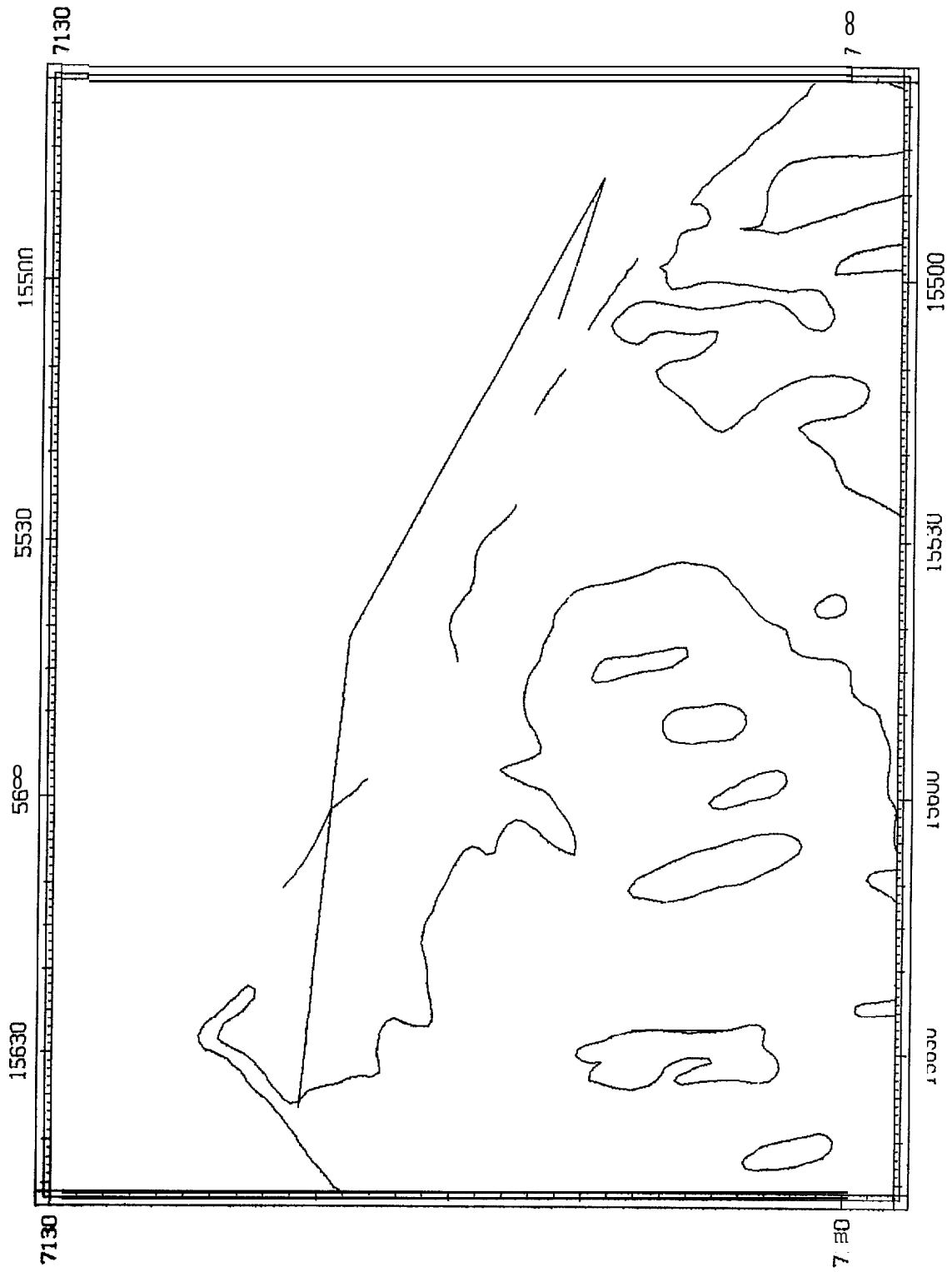


Flight #79, 5 October 1982

Flight was a line transect survey of block 11. Weather was overcast and visibility unlimited. Ice coverage was 7/10 to 8/10 with an open water channel near the 20-m contour. Sea state was Beaufort 00 to 02. Seven **bow-**heads, **belukhas** and ringed seals were sighted north of Deadhorse.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
3/0	71°21.8'	154°58.9'	327	BO	Sw	280	7	2	15
1/0	71°22.2'	154°58.8'	475.3	BO	Sw	210	7	2	11
1/0	71°27.0'	151°47.0'	338.8	BO	Ss	240	10	0	183
2/0	71°21.8'	154°57.4'	123.4	BO	DI	240	9	1	9

Flight #80, 7 October, 1982



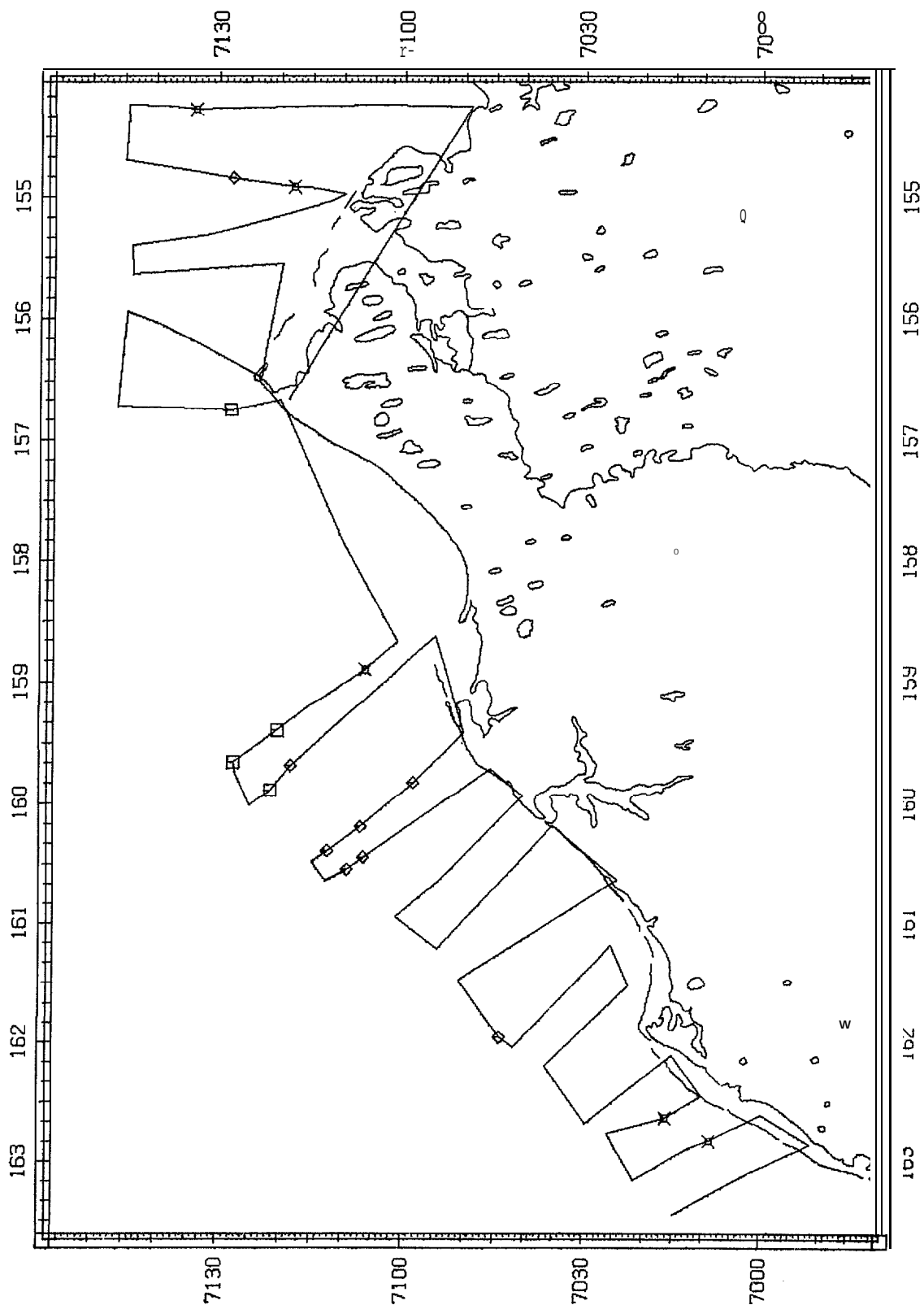
Flight #80, 7 October 1982

Flight was a short ice reconnaissance survey. A **line** transect survey of block 3 **was** aborted due to aircraft malfunction. Weather was overcast with snow squalls. Visibility ranged from 3 to 10 km. **Ice** between Barrow and Smith Bay was 9/10 new grease ice to 70 **km** offshore.

KEY FOR FLIGHT 81

- (BOWHEAD WHALE)
- ✕ (RINGED SEAL)
- ◇ (WALRUS)

Flight #81, 9 October, 1982



Flight #81 , 9 October 1982

Flight was a line transect survey of block 12 and block M to Pt. Lay. Weather was overcast with patchy fog. Visibility ranged from unlimited to less than 1 km. Ice coverage was 8/10 to 9/10 in the Beaufort and northern **Chukchi** Sea, decreased to 4/10 off **Wainwright**, then increased to 7/10 to 8/10 to Pt. Lay. Sea state was Beaufort 00. Nine bowheads were sighted, eight **of** them in the northern **Chukchi** Sea. Walrus, ringed seal and polar bears were also sighted. One **sonobuoy** was dropped near the bowheads, but no sounds were recorded.

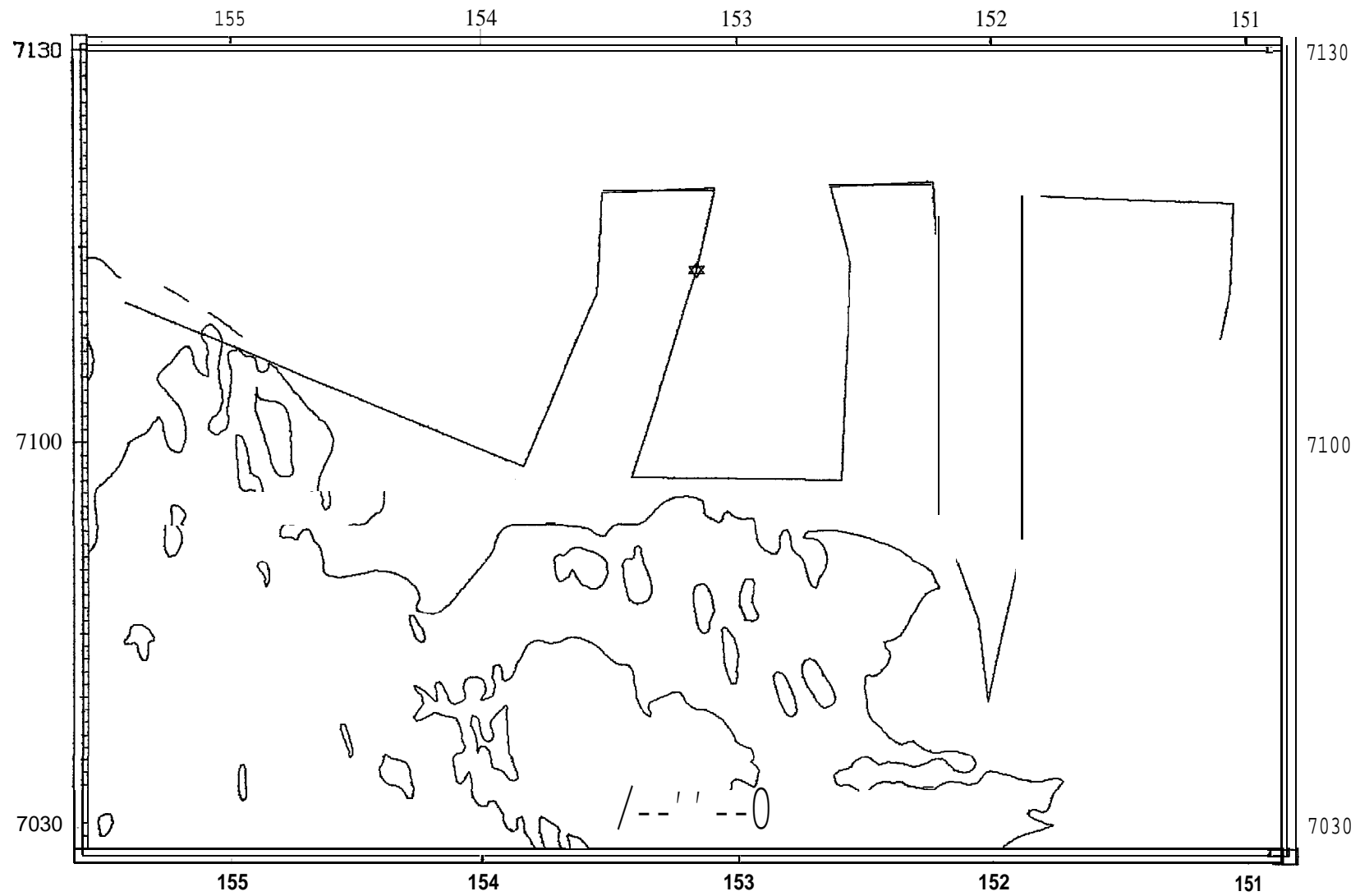
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°28.0'	156°44.8'	363.3	BO	SW	240	9	0	44
1/0	71°20.4'	159°23.9'	140.8	BO	SS	180	8	0	48
4/0	71°27.4'	159°39.3'	797.8	BO	GS		8	0	49
3/0	71°21.5'	159°53.4'	718.2	BO	SW	300	9	0	44

KEY FOR FLIGHT 82

Flight #82, 10 October, 1982

✱ (BEARDED SEAL)

A-168



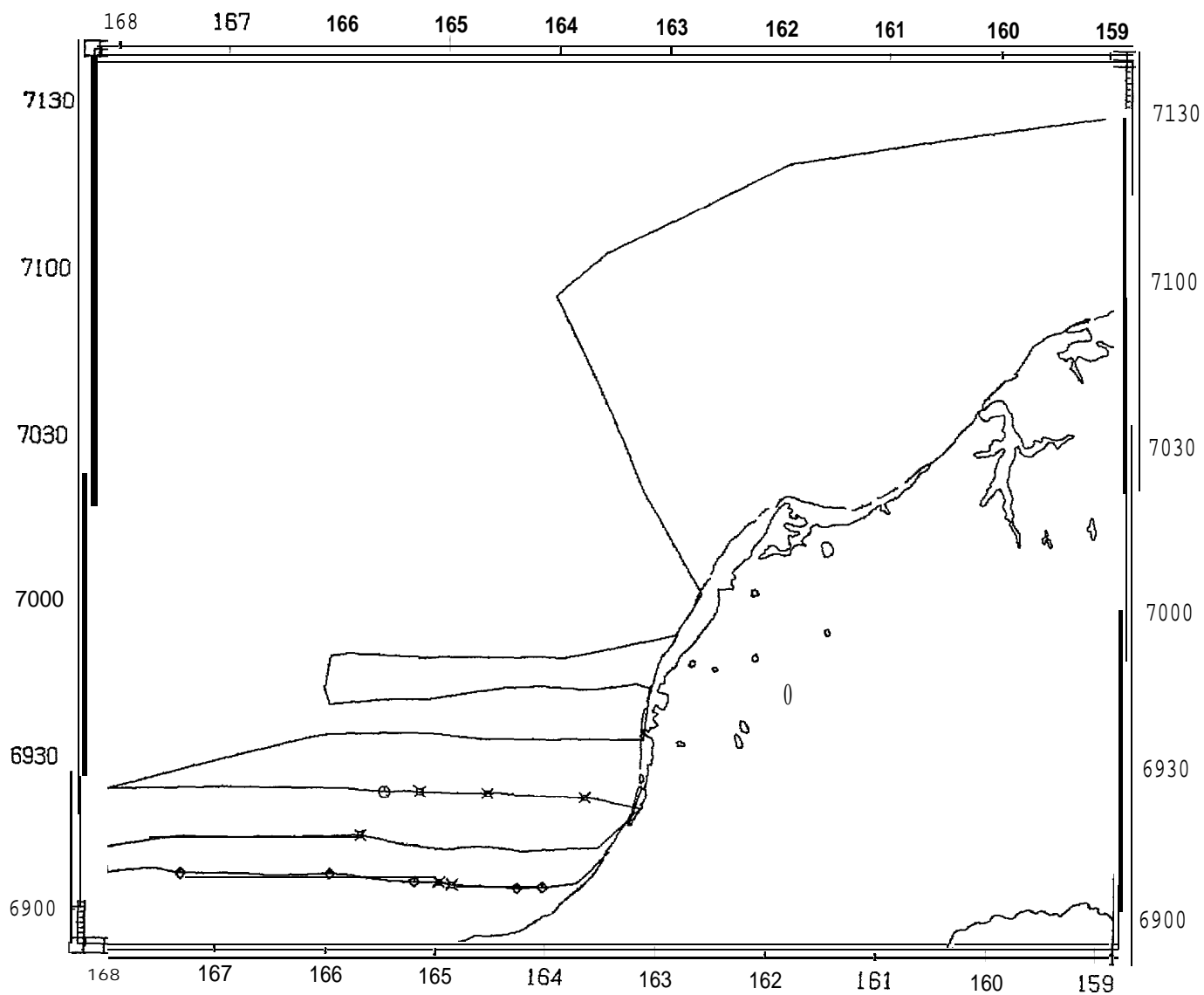
Flight #82, 10 October 1982

Flight was a line transect survey western half of block 3. Weather was overcast to heavy fog in Harrison Bay where the transect was aborted. Ice coverage ranged from 9/10 to 10/10. Sea state was Beaufort 00. One bearded seal was the only marine mammal sighted.

KEY FOR FLIGHT 83

Flight #83, 11 October, 1982

○ (GRAY WHALE)
 X (RINGED SEAL)
 ◇ (WALRUS)



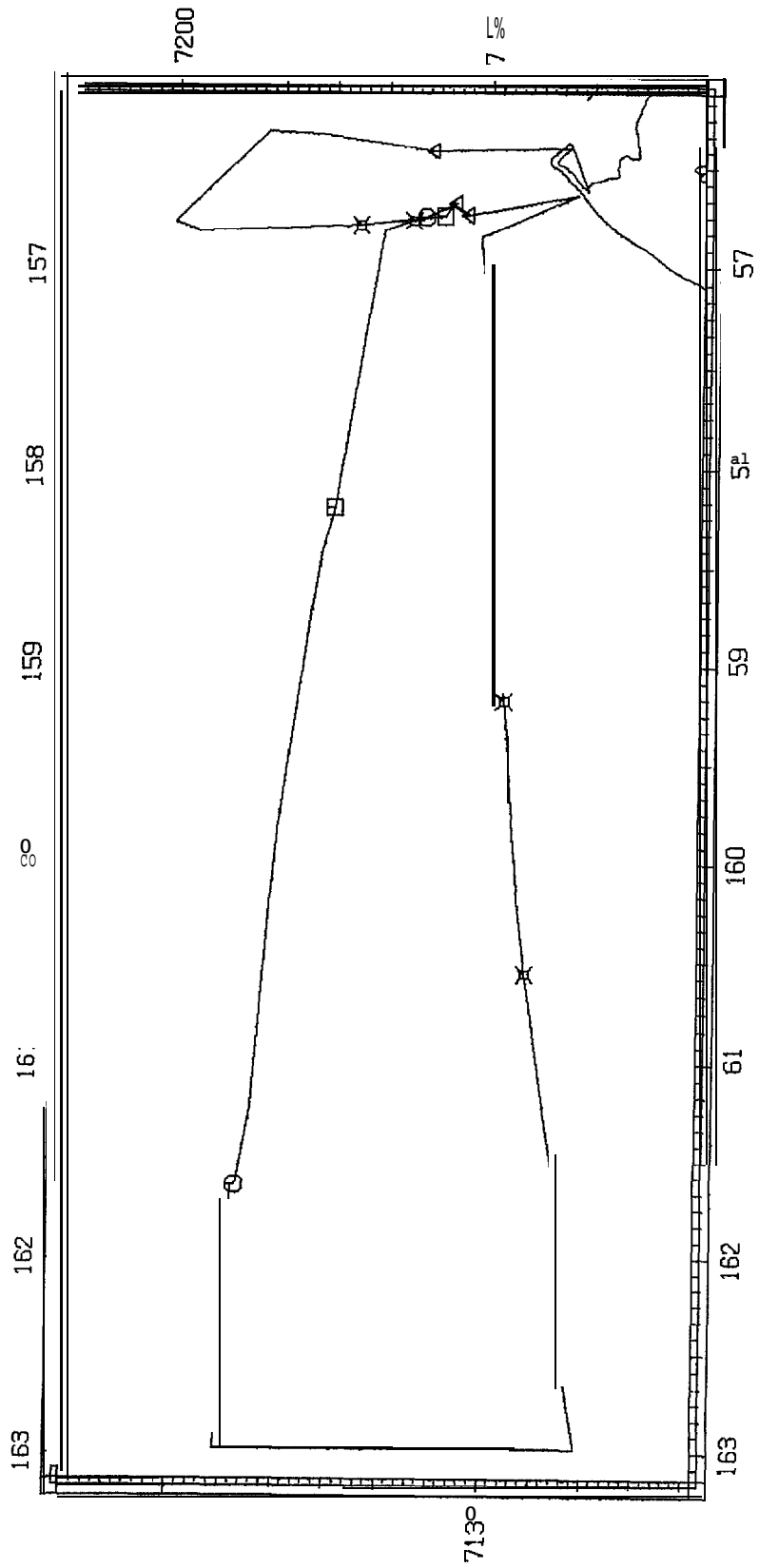
Flight #83, 11 **October** 1982

Flight was a line transect of the southern half of block M with a search survey approximating a 20-m depth contour between Pt. Lay and Pt. Barrow. Weather ranged from partly cloudy to **low** overcast. Visibility was unlimited. Sea state was between Beaufort 01 to 02. Ice coverage ranged from 4/10 to 9/10 from 165°W longitude to shore, with the heaviest ice east of **164°15'W.** Two gray whales, walrus and ringed seals were sighted. One **sonobuoy** was dropped, but no sounds were recorded.

KEY FOR FLIGHT

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)
- × (RINGED SEAL)
- (POLAR BEAR)

Flight #84, 12 October, 1982



Flight #84, 12 October 1982

Flight was a line transect **survey** of the western **third** of block 12 and two 180 km east-west legs in the northern end of block M. Weather was partly cloudy with areas of **patchy** fog. Visibility was unlimited to less than 1 km. Sea state was Beaufort 00. Ice coverage was **9/10 to 10/10**. Three bowheads were sighted, two in the **Chukchi** Sea. **Belukhas**, ringed seals and polar bears were also sighted.

T#/C#	LAT(N)	LONG(W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71°34.6'	156°44.8'	170.8	BO	SW		10	0	91
1/0	71°29.0'	158030.1 '	85.3	WD	SW	240	8	0	60
1/0	71°44.9'	158°11.9'	203.2	BO	SW	210	9	0	66

☐ (BOWHEAD WHALE)
☐ (POLAR BEAR)
☐ (NO SIGHTING)

A-174

Flight #85, 15 October 1982

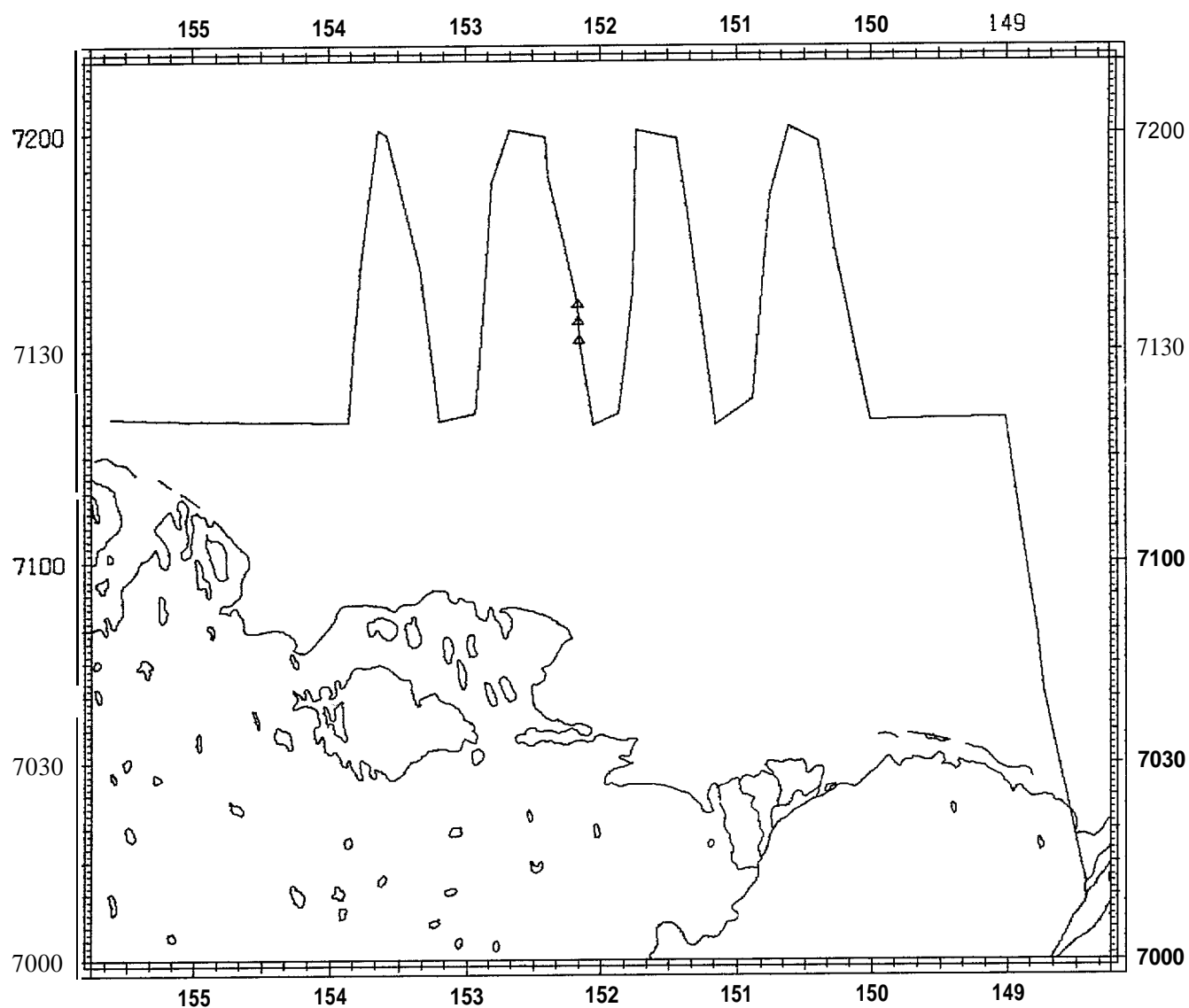
Flight was a search **survey** around Mackenzie Bay and along offshore cracks and leads back to Deadhorse. Weather was partly cloudy with some areas of patchy fog. Visibility was unlimited to 3 km. Ice coverage was 9/10 to Herschel Island, but dropped to less than **1/10** in Mackenzie Bay where the sea state averaged Beaufort 02. One bowhead was sighted just north of Herschel Island. Polar bears were also seen.

T#/C#	LAT(N)	LONG(W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	69°36.7'	138°51.8'	528.1	WD	SW	180	7	2	18

KEY FOR FLIGHT 66

Flight #86, 16 October, 1982

△ (BELUGA WHALE)



Flight #86, 16 October 1982

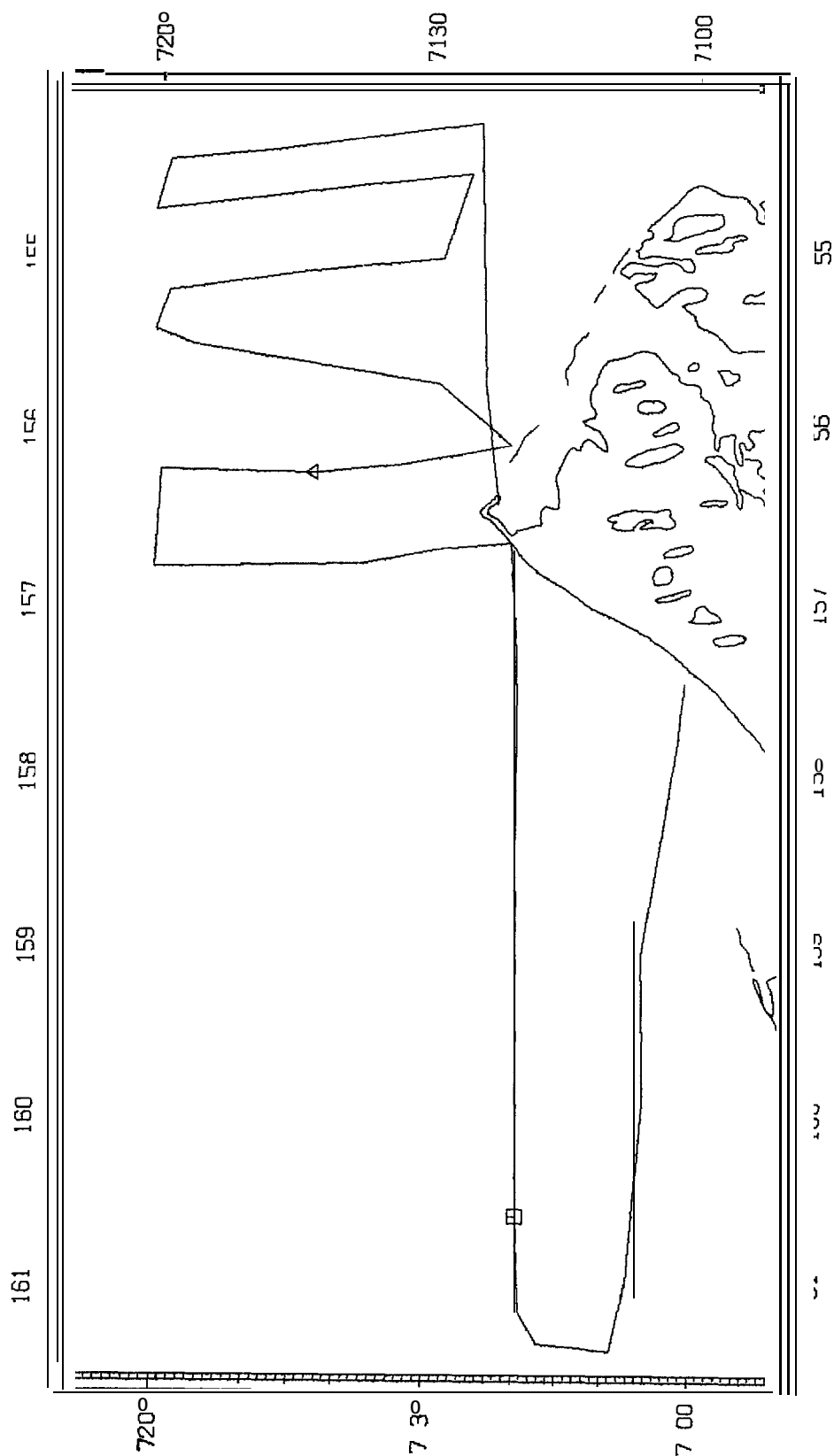
Flight was a line transect survey of block 11. Weather was clear, visibility unlimited. Ice **corage** was 9/10 to 10/10. Sea state was Beaufort 00 to

03. Belukhas were the only marine mammals sighted.

KEY FOR FLIGHT 87

- (BOWHEAD WHALE)
- △ (BELUGA WHALE)

Flight #87, 17 October, 1982



Flight #87, 17 October 1982

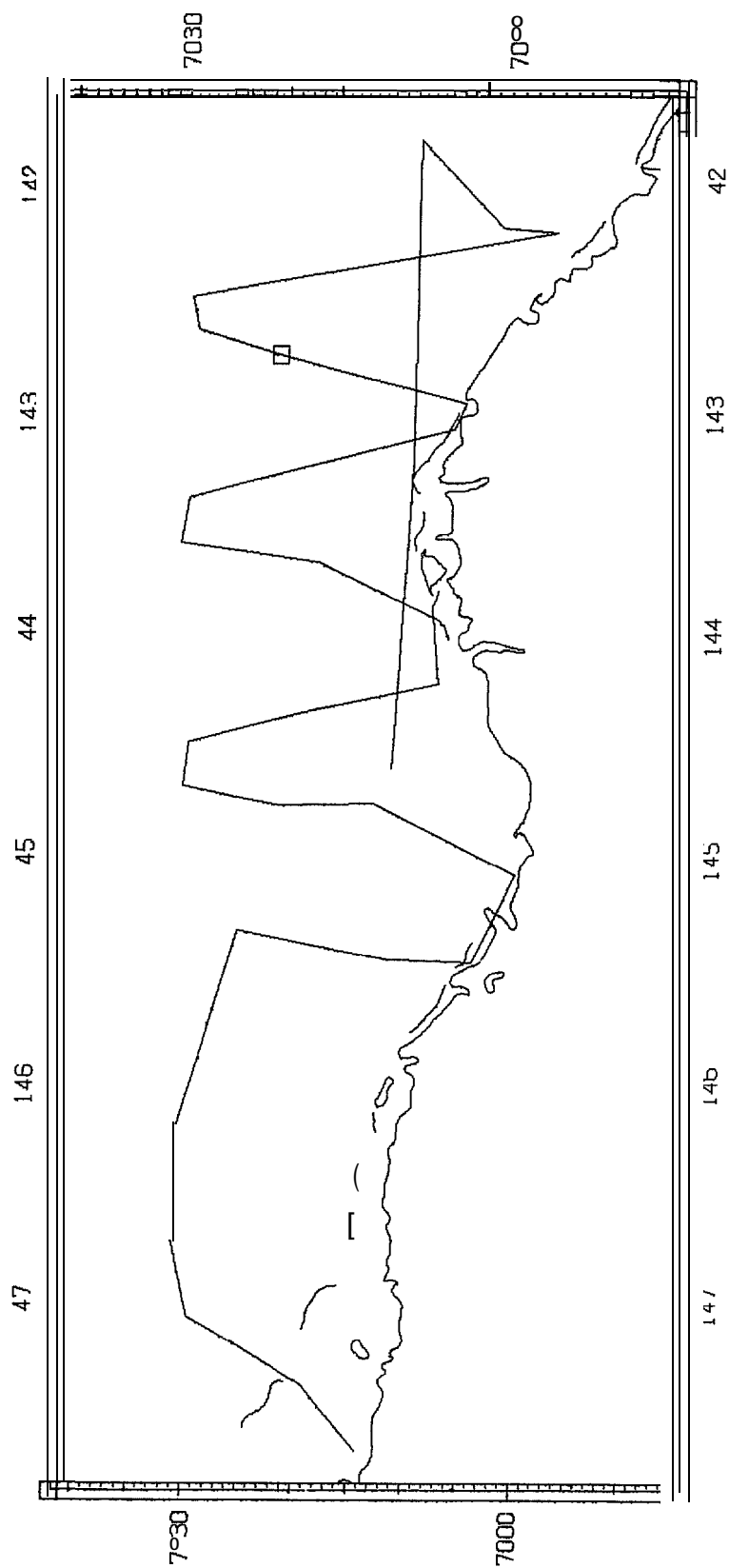
Flight was a line transect survey of block 12 and 2 legs in block M. Weather ranged from partly cloudy to fog; visibility from excellent to unacceptable. Ice coverage was 9/10 to solid breaking to 6/10 to 7/10 off Barrow. Sea state was Beaufort 00 to 02. One bowhead was sighted in the Chukchi Sea. **Belugas** were seen in the Beaufort Sea approximately 30 km north of Pt. Barrow.

This flight terminated N780 survey efforts for 1982.

T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	71019.7'	160034.1 '	598.4	BO	SW	180	8	2	46

Flight #88, 6 October, 1982

E (BOWHEAD WHALE)

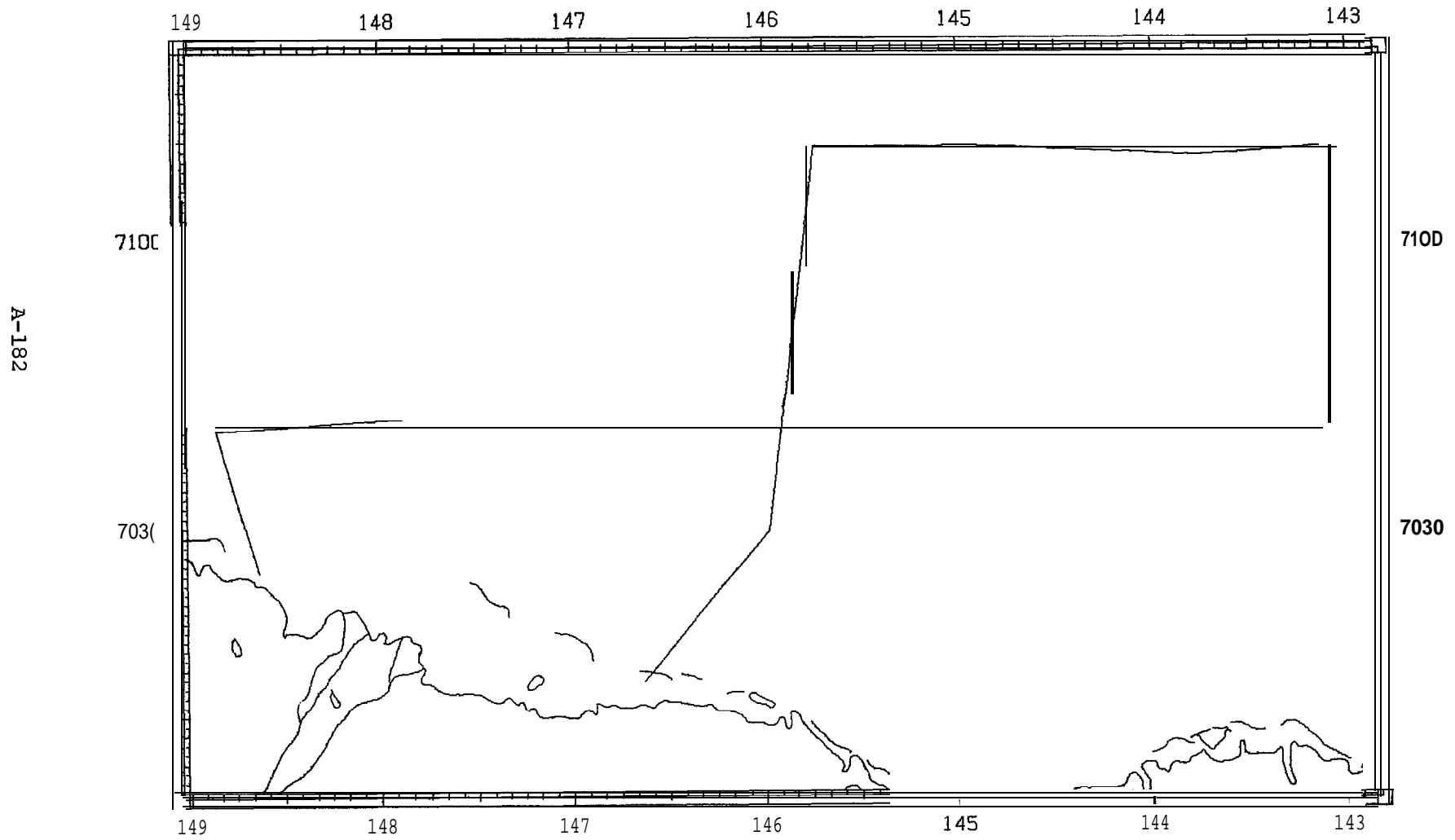


Flight #88, 6 October 1982 (N-642)

Flight was a line transect survey of block 4 and 2 legs of block 5. Weather was overcast with some patchy fog. Visibility ranged from 3 km to unlimited. Ice coverage ranged from 8/10 to 9/10 grease ice to 70°15'N latitude, dropping there to 0/10 with sea state Beaufort 01 to 02. Three bowheads were sighted in Camden Bay.

T#/C#	LAT(N)	LONG(W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
3/0	70°21.6'	142°44.7'		BW	SW	270	1	1	46

Flight #89, 9 October, 1982



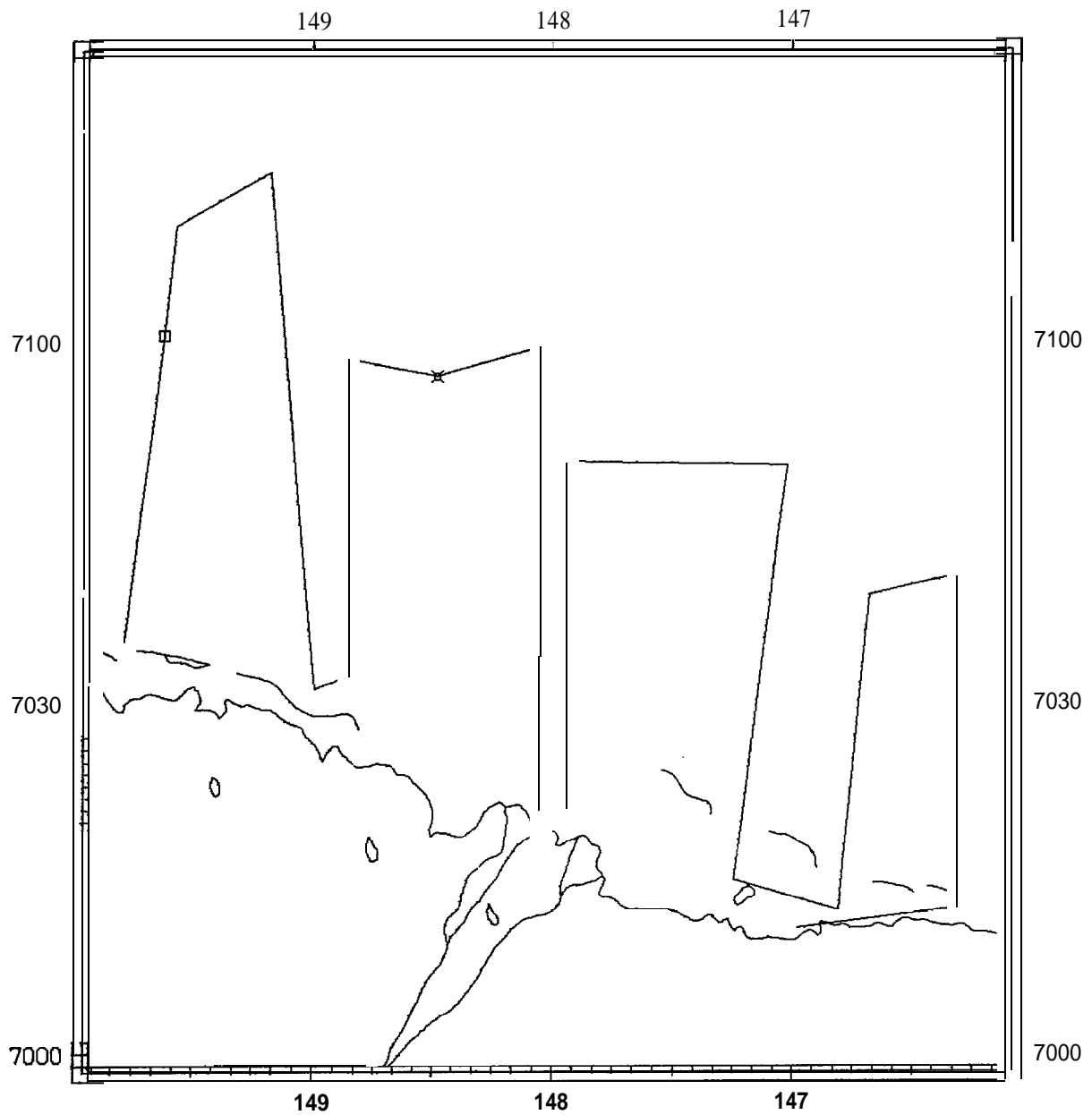
Flight #89, 9 October 1982 (N-642)

Flight was a search survey to assess ice coverage along the northern edge of block 6 then west along the **70°40'N** line. Weather was overcast with patchy fog. Visibility was generally unlimited. Ice coverage was 9/10 to 10/10. No marine mammals were sighted.

KEY FOR FLIGHT 90

Flight #90, 11 October, 1982

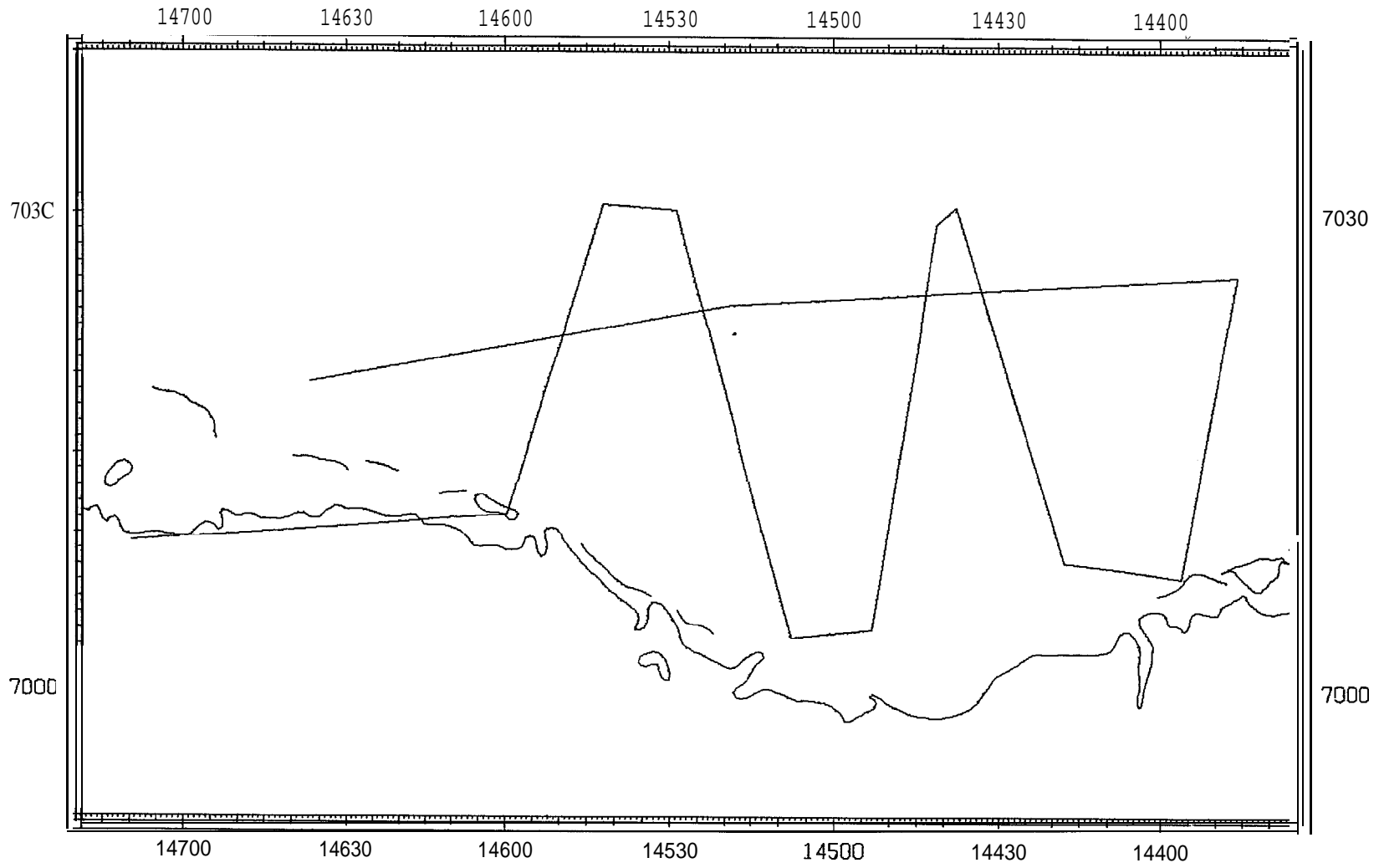
✕ [RINGED SERL 1
□ (POLAR BEAR)



Flight #90, 11 **October** 1982 (N-642)

Flight was a line transect survey of block 1. Weather varied from clear to patchy fog, with occasional snow squalls. Visibility ranged from unacceptable to unlimited. Ice coverage was 9/10 to 10/10. A polar bear and five unidentified pinnipeds were the only marine mammals.

Flight #91, 12 October, 1982

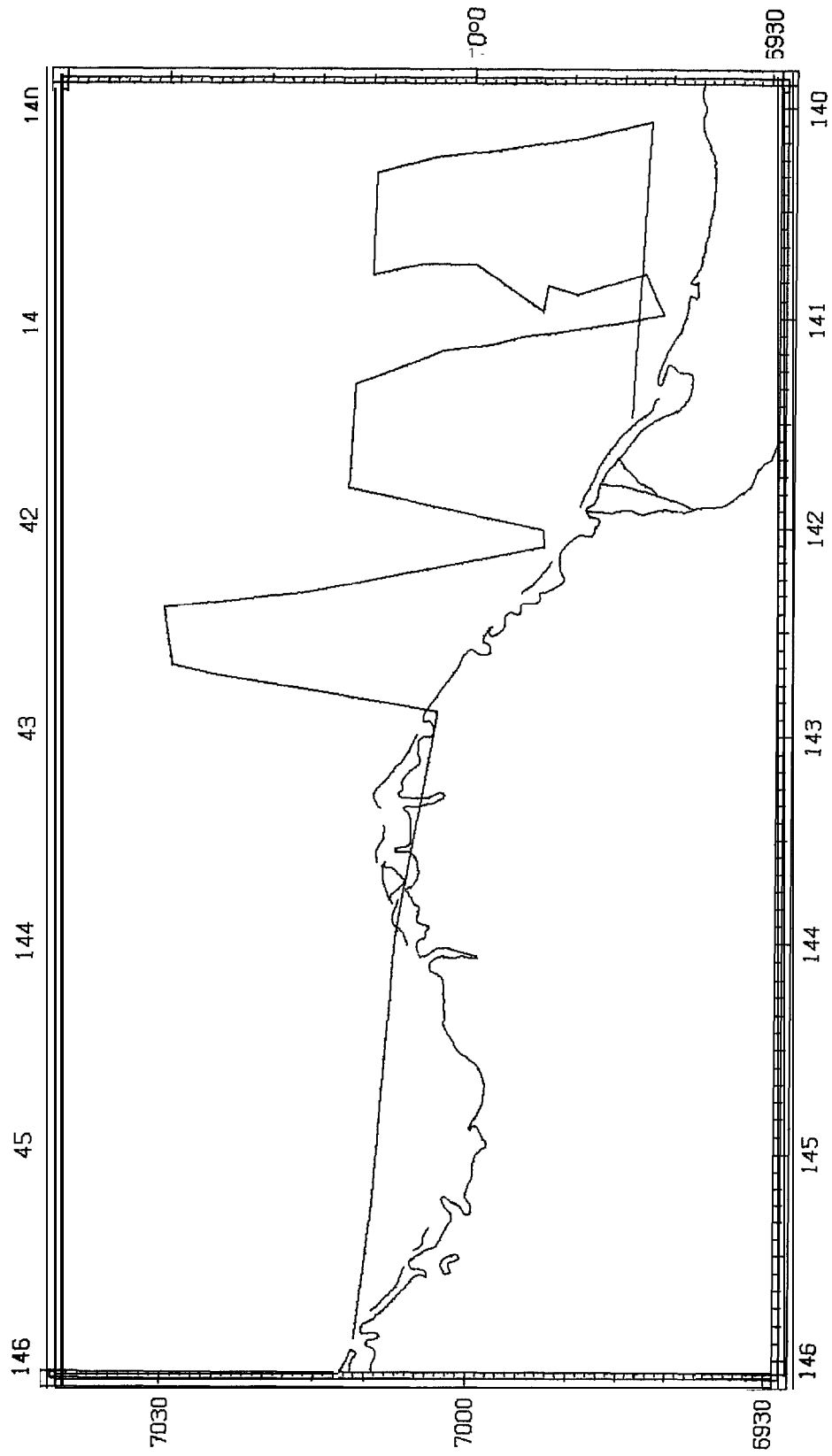


UNCLASSIFIED

Flight #91, 12 October 1982 (N-642)

Flight was a line **transect** survey of block 4. Weather was heavy fog. Visibility was generally unacceptable. Ice coverage was 9/10 to 10/10. No marine mammals were sighted.

Flight #92, 13 October, 1982



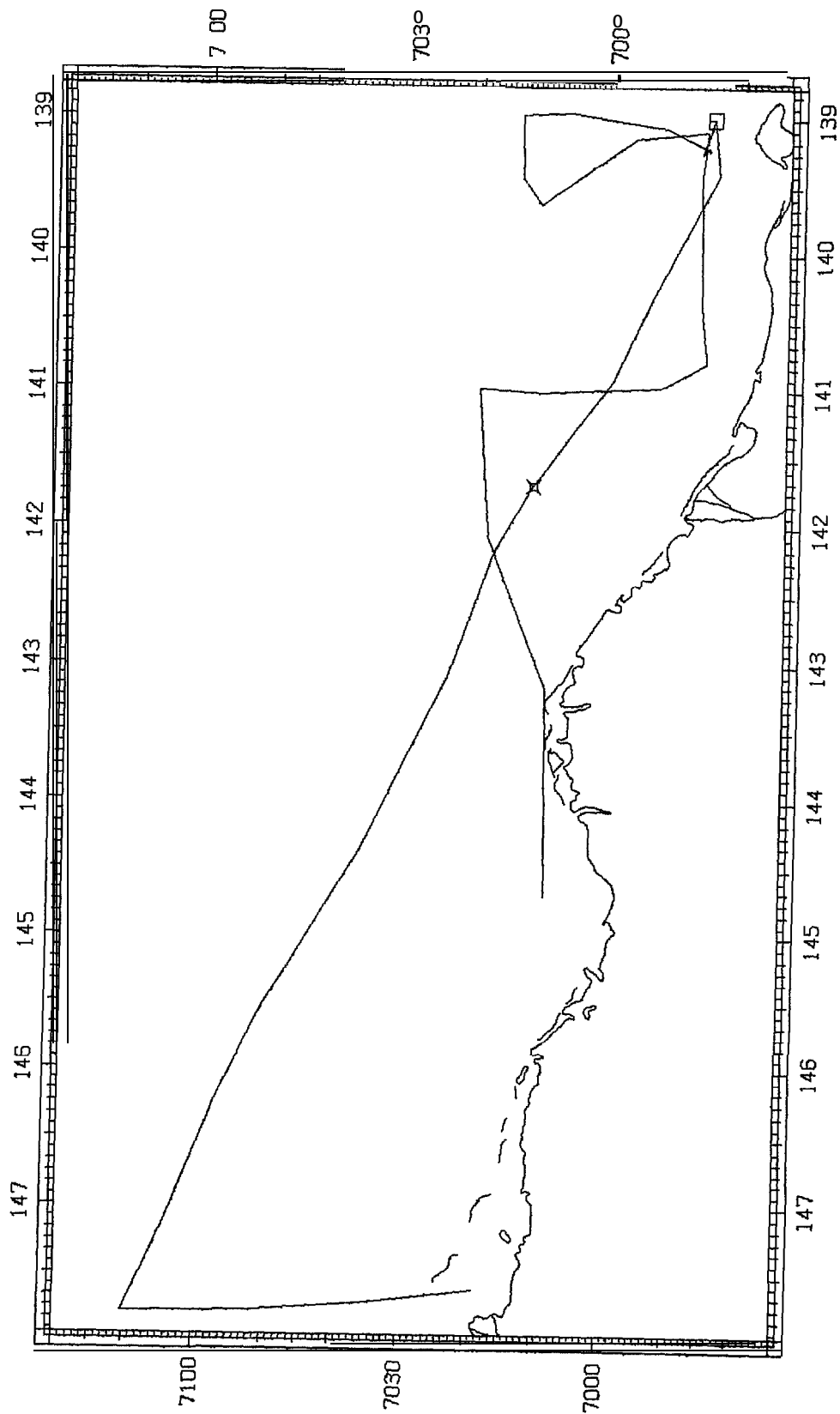
Flight #92, 13 October 1982 (N-642)

Flight was a line transect survey of block 5. Weather varied from patchy fog to heavy fog. Visibility was **geneally** less than 1 km. Ice coverage was 9/10 to 10/10, except for an approximately 1 km² area of open water at **69°50'N, 140°55'W**. Sea state in the open water area was Beaufort 03. No marine mammals were sighted.

KEY FOR FLIGHT 93

- (BOWHEAD WHALE)
- ✕ (RINGED SEAL)

Flight #93, 14 October, 1982



Flight #93, 14 October 1982 (N-642)

Flight was a search to access ice coverage east of **148°W** longitude. Weather was generally clear. Visibility was unlimited. Ice coverage was 10/10 to Herschel Island, but dropped to less than 1/10 in Mackenzie Bay where the sea state was **Beaufort** 02. One bowhead was sighted north of Herschel Island. Ringed seals were also seen.

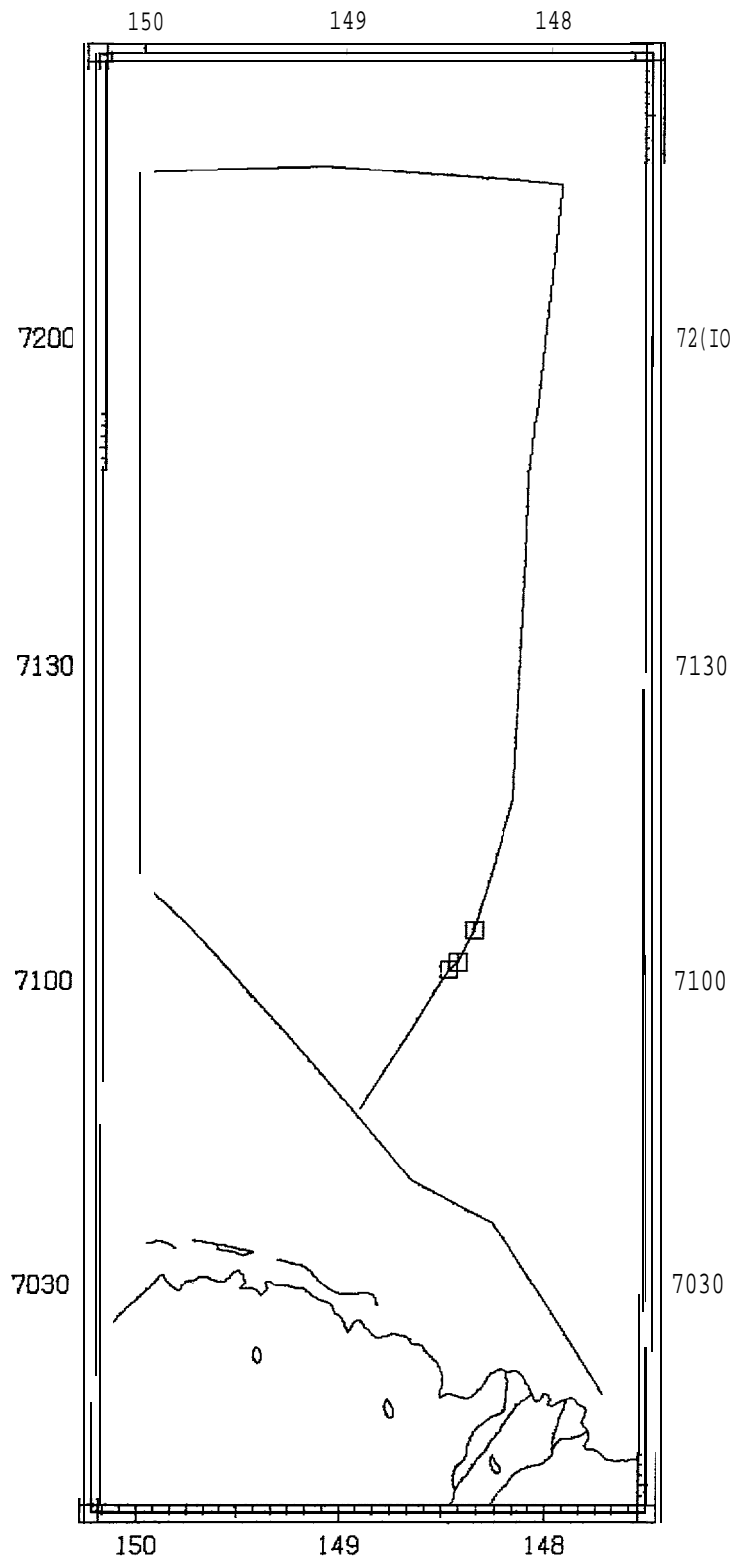
T#/C#	LAT(N)	LONG (W)	DIS(M)	CUE	BEH	HDG	ICE	SS	DEPTH(M)
1/0	69°45.0'	139000.0'		BO	SS	030	3	1	18

Flight #94,

KEY FOR FLIGHT 94

15 October, 1982

•1 (POLAR BEAR)



Flight #94, 15 October 1982 N-642)

Flight was a search survey to access ice coverage north to **72°15'N** latitude along the **150°W** longitude line, then south along **148°W** longitude. Weather was clear with low ceiling. Visibility was unlimited. Ice coverage was 10/10. Three polar **bears were the only mammals sighted.**

APPENDIX B

DISTRIBUTION OF 1982 SURVEY EFFORT

AND

OBSERVED DENSITIES **OF BOWHEAD** AND GRAY WHALES

IN THE BEAUFORT, **CHUKCHI** AND BERING SEAS,

WITH COMPARISONS TO 1979-1981

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INTRODUCTION

The following section presents an analysis of aerial survey data collected during 1982 and a brief comparison to similarly analysed data for 1979-1981. The objectives of the analysis were to determine distribution and density of bowhead whales in the **Beaufort, Chukchi** and Bering Seas, and distribution and density of gray whales in the Bering and **Chukchi** Seas. An important component of this analysis was determination of the distribution of survey effort.

The Beaufort Sea **was** treated as two study areas: the general Beaufort Sea bounded by 141 00' W to 157 00' W longitude and 72 00' N latitude to the coastline, and the Barrier Islands region bounded by 146 00' W to 150 00' W longitude and 71 16' N latitude to the coastline. The Bering and **Chukchi** Seas were treated as one study area. All three study areas were subdivided for the purpose of more precise illustration of survey effort and density of animals.

Distribution of survey effort and density of bowhead whales in the Beaufort Sea study areas were examined during Spring (April-May) and Summer (June-August) and again during Fall (September-October). In the Bering and **Chukchi** Seas, distribution of survey effort and density of bowhead whales was examined during Spring. Distribution of survey effort and density of gray whales in the Bering and **Chukchi** Seas were examined during Summer (June-August).

METHODOLOGY

Map Preparation

Maps were prepared using the computer program AMP, A Mapping Package, consisting of FORTRAN subroutines which can be used for customized plotting applications. AMP was used to plot aerial survey data which resided on file as a series of geographic coordinates (latitude and longitude) associated with time and sightings of whales. Land masses are part of the AMP data base. Depth contours were plotted by reading a separate file of data points prepared for this analysis.

Depth contours were digitized using several reference maps. It was necessary to use more than one map because not all contours were available on any one map. The U.S. Geological Survey map "Open - File 76-823, Sheet 1 or 2" was used to digitize the 50m and greater depth contours, plus all contours shown in the **Chukchi** Sea except for the 30m depth contour off the Soviet coastline. The 30m depth contour off the Soviet coastline and in the Bering Sea was taken from U.S. Department of Commerce map "514, 4th Ed., Apr. 11/81." In the Beaufort Sea, the 10m, 20m, and 30m depth contours were taken from two maps labeled "Data from: Geophysical Corp. of Alaska, 1975, NOAA, Dept. of Commerce Charts, U.S.G.S. Dept. of Interior Charts" which were additionally labeled as "Eastern Beaufort Sea" and Western Beaufort Sea."

When the depth contours were merged onto a single data file and plotted, some inconsistencies became apparent. For example, a 30m depth contour from one map file crossed over the 50m depth contour from another map file. When

this situation occurred, a portion of one of the depth contours was "clipped" to resolve the inconsistency. Note that portions of the 20m and 30m depth contours were clipped near Point Barrow, Alaska, and that the 50m depth contour was clipped near Saint Lawrence Island in the Bering Sea.

Data Processing and Quality Control

A computer program was written to screen for bad data values. The chronological order of time was checked. Aerial survey data files were screened for obvious errors in geographic position by plotting separately the course of each daily aerial survey. A computer program was used to calculate flight speeds and distances on a point to point basis, and listings of these values were scanned for suspiciously slow or fast speeds. The listings and maps were compared; errors were flagged and edited; and the process was repeated until data files were error-free with respect to these conditions.

Definition of Areas and Methodological Limitations

The total Beaufort Sea study area was divided from east to west based on proximity to oil lease sites (Figure B-1). Region A is west and adjacent to the lease areas extending from 153 30'W to 157 00'W longitude. Region B extends from 150 00'W to 153 30'W longitude, representing the western lease area. Region C extends from 146 00' to 150 00'W longitude, representing the eastern lease area. And, Region D is east and adjacent to the lease area extending from 141 00'W to 146 00'W longitude.

Depth contours (Figure B-2) were used to stratify the Beaufort Sea from north to south corresponding to water depth. Preliminary analysis of survey data indicated that there was a relationship between water depth and distribution of bowhead whales. Depth contours of 10m, 20m, 50m, 200m and 2000m were selected (Figure B-3, Figure B-4).

The stratum from the coastline to 10m corresponded closely to the area inside the barrier islands (A1, B1, C1, D1A, and D1B). Area D1 was divided into D1A and D1B at 143 30'W, which marked the boundary between two areas previously defined for behavioral studies (Figure B-5).

The shelf area was stratified from 10m to 20m, 20m to 50m, and 50m to 200m. Areas A2, B2, C2, D2A, and D2B corresponded to the 10m to 20m strata. Area D2 was divided similarly to D1. Areas A3, B3, C3, and D3 corresponded to the 20m to 50m stratum. Areas A4, B4, C4, and D4 corresponded to the 50m to 200m stratum.

Offshelf strata were defined from 200m to 2000m and deeper than 2000m. Areas A5, B5, C5, and D5 corresponded to the 200m to 2000m strata. Areas B6, C6 and D6 corresponded to the deeper than 2000m strata.

The comparatively shallow Bering and Chukchi Seas were not subdivided on the basis of depth contours; rather, regions (Figures B-25, B-26) were determined based on survey effort and animal distributions.

The Barrier Islands study area was bounded on the east by 146 00'W

longitude and on the west by 150 00'W longitude (Figure B-40). The Barrier Islands and depth contours (Figure B-41) were used to stratify the Beaufort Sea from north to south corresponding to water depth. Preliminary analysis of survey data indicated that there was a relationship between water depth and distribution of bowhead whales. Depth contours of 20m, 50m, and 200m were selected (Figure B-42).

The region from the coastline to the nearshore coastline of the Barrier Islands corresponded to region 1. The shelf area from the seaward coastline of the Barrier Islands to the 20m depth contour correspond to region 2. Region 3 corresponded to the 20m to 50m stratum. Region 4 corresponded to the 50m to 200m stratum. Region 5 extended from the 200m depth contour to the northern boundary of the study area, 71 16'N latitude.

The digitizer was used to trace region boundaries, which led to a boundary problem termed "splinter error". The technique used to digitize each region was to circumscribe it by tracing the boundary of the region. Thus, when two regions were adjacent, the common boundary would be digitized twice. In fact, a boundary was often digitized more than twice. For example, the boundary between regions A1 and B1 was digitized four times because it served not only as a boundary between A1 and B1 but also between the larger regions A and B. A splinter error occurred when one set of points defining a common boundary did not exactly match the second, third or fourth set of points used to define the same boundary for other regions.

Because of this splinter error problem, a very small percentage of the total area may be shared by two regions or may be left out of a region. For example, because of overlap, a small portion of the Beaufort Sea may have been shared during the analysis of two adjacent regions. Conversely, if two sets of points defining a common boundary diverged slightly, a small portion of the Beaufort Sea could have been left out of the analysis.

The implications of the splinter error problem in relation to this study are small. Statistics reported for each sub-region, region and the total study area are valid, but there may be small discrepancies when the values of sub-regions are summed and compared to the values reported for larger regions, e.g., number of survey hours flown, listed in the tables as Survey Time.

Statistics Presented in Tables

Region Area nmi² - Areas were approximated by straight line integration which contributed to discrepancies between the summation of sub-region areas and areas calculated for larger regions. Area calculations are accurate to within about 1 percent of the true area.

Percent of Total Area - The percent of total area was calculated as the region area divided by the sum of all sub-region areas; this quantity was then multiplied by 100.

Percent of Area Surveyed - The percent of area surveyed is a relative measure of survey effort expended per survey region. Strip width was defined as one nautical mile. Therefore, the total number of miles flown equalled the total number of square nautical miles surveyed. The percent of total area was

calculated as the number of nautical miles surveyed divided by the region area; this quantity was then multiplied by 100.

This technique did not account for overlapping aerial survey strips which result in double counting the area surveyed. Therefore, some areas surveyed may show more than 100 percent coverage.

Survey Time **HR:MIN** - The time in hours and minutes spent surveying an area. Because of splinter errors and rounding errors, the values reported for time spent surveying sub-regions did not always equal those reported for larger regions.

Percent of Total Time - The time in hours and minutes spent surveying a region divided by the sum of survey times reported for each sub-region.

Number of Transects Flown (**=n**) - Transects or flight legs were defined as units of survey effort by the aerial survey team. The beginning and ending of transects were further defined by the survey region boundaries. A portion of an aerial survey leg passing over a region was treated as a transect relative to that region. Thus, one transect could be broken into several transects with respect to sub-region analyses. For this reason, the sum of the transects based on sub-regions was greater than the total number of transects reported for the total region.

Number of Bowheads Observed - The number of bowhead whales observed within one half nautical mile of either side of the aircraft. In contrast, whale sightings depicted on maps include all whales sighted, regardless of their distance from the aircraft. Because of splinter errors, small discrepancies may occur between the sum of the number of whales observed in each sub-region versus the number reported for larger regions.

Density as Number per nmi², Variance and Confidence Range - Calculation of density statistics for each stratum followed the method employed by Krogman et. al. (1979). which was based on the technique described in Estes and Gilbert (1978):

$$(1) \hat{R} = \sum y_i / \sum x_i$$

where \hat{R} = observed density of whales per square nautical mile

y_i = number of whales observed in the i th strip transect

x_i = area of the i th strip transect

$$(2) s_{\hat{R}}^2 = [\sum (y_i^2 / x_i) - \hat{R}^2 \sum x_i] / (n-1) (\sum x_i)$$

where $s_{\hat{R}}^2$ = variance of \hat{R}

n = number of strip transects

The confidence interval was calculated as:

$$(3) \text{ C.I.} = \hat{R} \pm t_{.05(2)V} \sqrt{V(\hat{R})}$$

The notation $t_{.05(2)V}$ refers to the critical value of t where

alpha (α) = .05 (1- = .95) based on a two tailed test with V degrees of freedom. Degrees of freedom were calculated as the total number of transects minus one.

Results and Discussion

Results are presented by area, season, and species. Each presentation consists of:

- 1) Figure depicting aerial survey **tracklines**, sightings and region boundaries.
- 2) Figure depicting whale sightings, depth contours and/or region boundaries.
- 3) **Table** of statistics associated with each region.
- 4) Figure depicting percent aerial survey coverage for each region.
- 5) Figure depicting observed density of whales for each region.

The 1982 fall Beaufort hi-monthly section does not present items 4 and 5.

Please refer to the table of contents for order of presentation of aerial surveys results. Figures and tables are intended to be self explanatory. An abbreviated summary statistics table for 1979-1981 data follows and is briefly compared to the presentation of 1982 data. The reader is directed to Ljungblad et al., 1982 Appendix B for a complete presentation of 1979-1981 results.

BEAUFORT SEA STUDY AREA

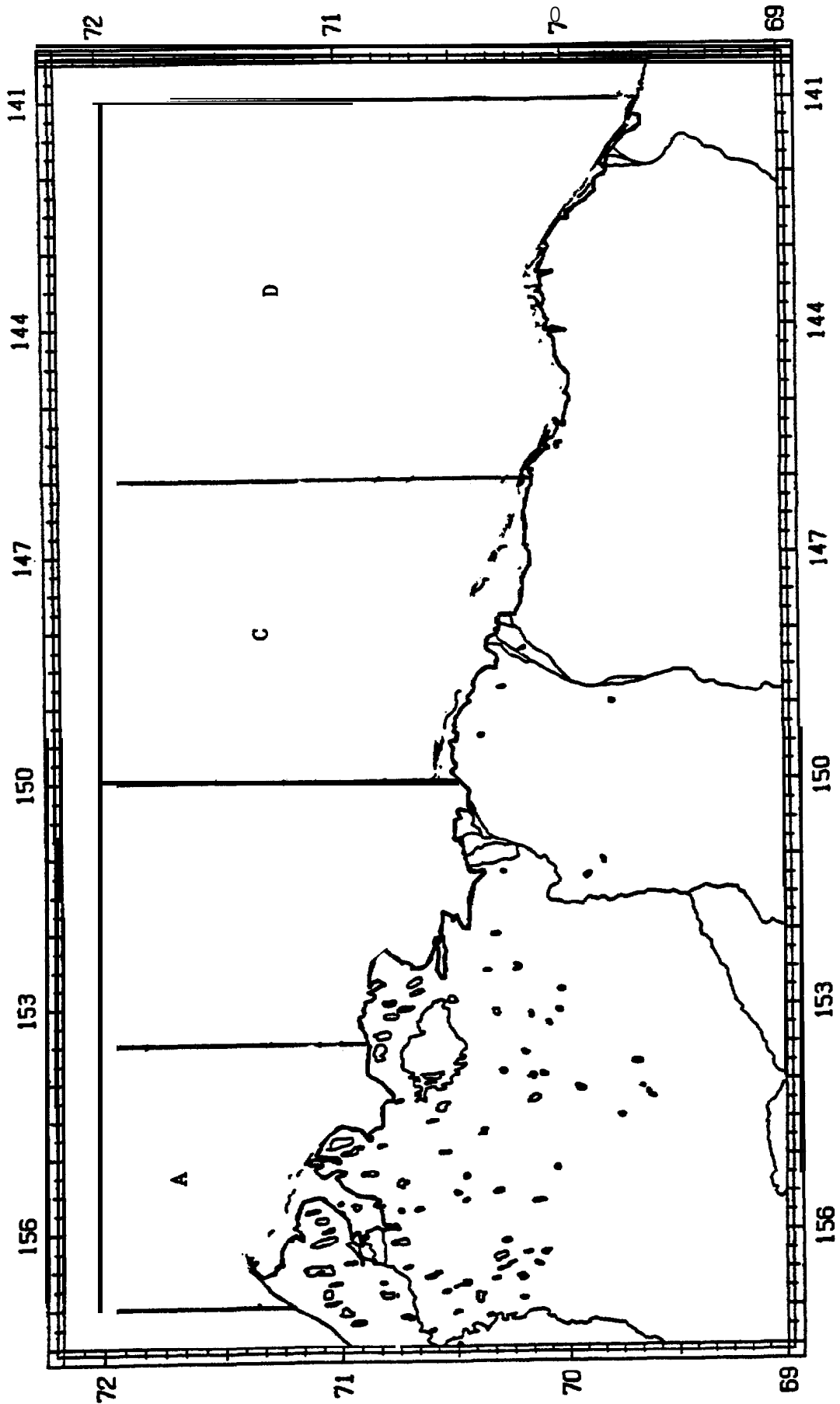


Figure B-1. The Beaufort Sea study area was divided into four regions: A, B, C, and D.

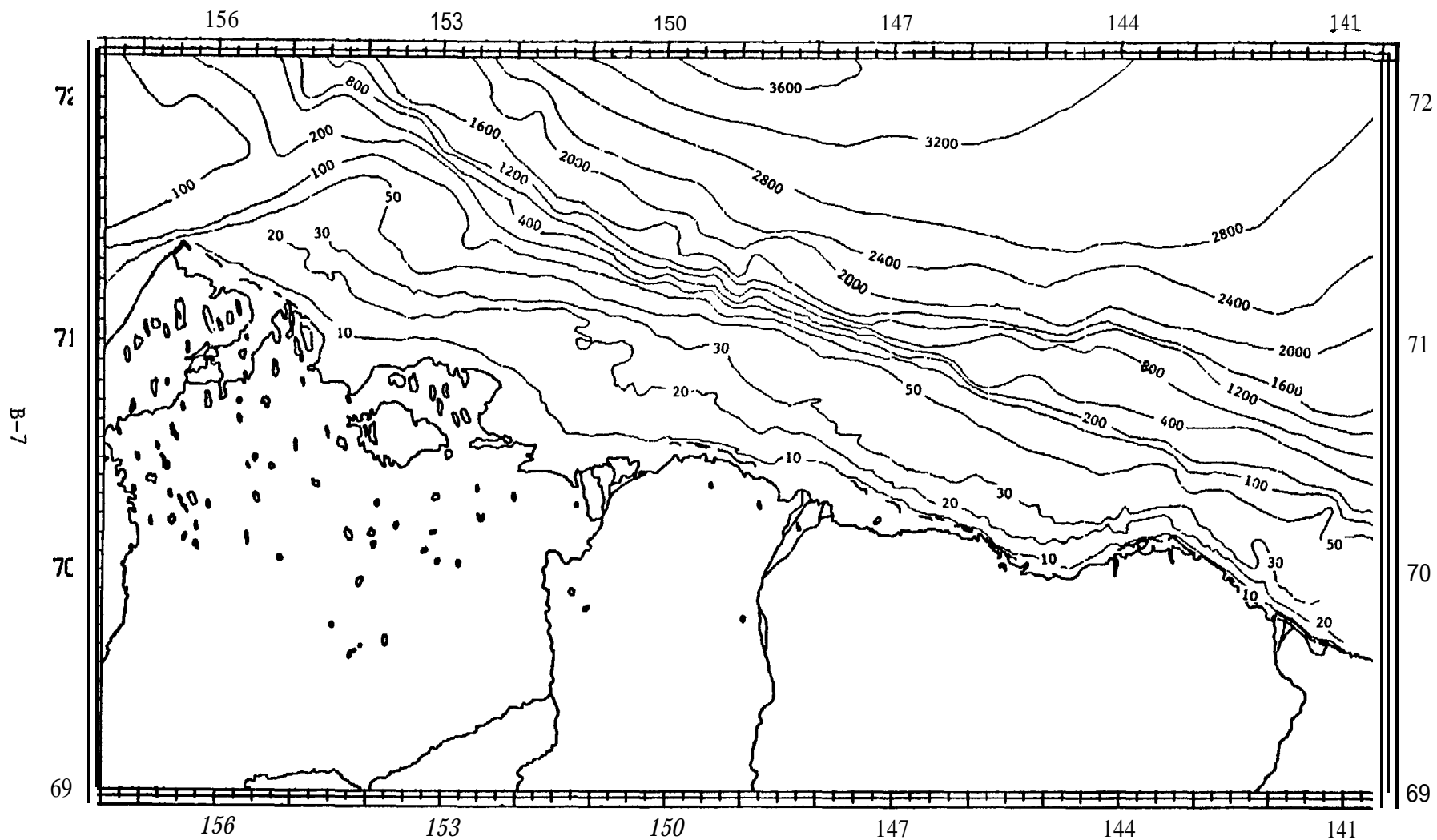


Figure B-2. Beaufort Sea depth contour lines, in meters.

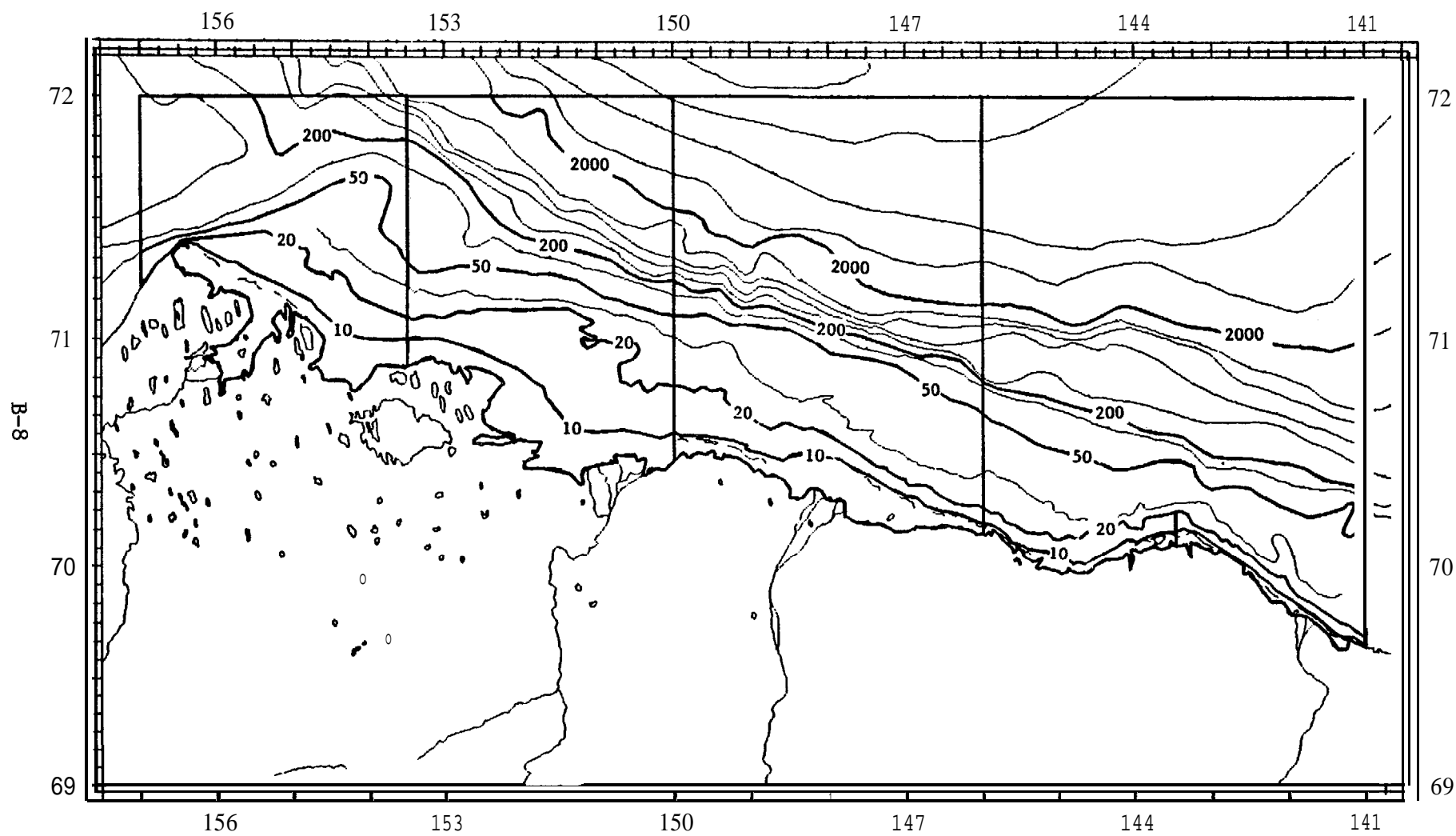


Figure B-3. Map depicting the survey regions in the Beaufort Sea after stratification by contour intervals of 10m, 20m, 50m, 200m, and 2000m.

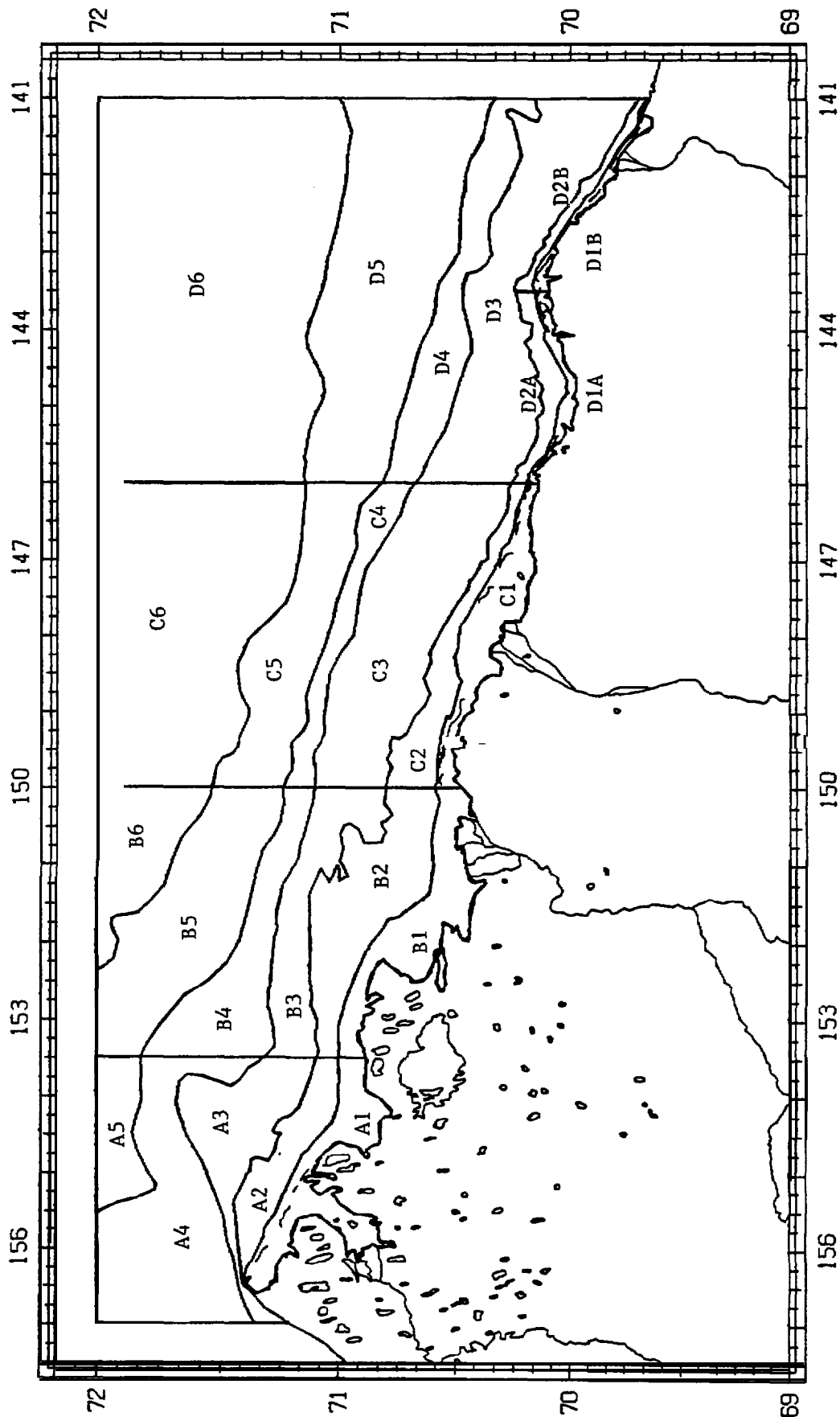


Figure B-4. Map depicting Beaufort Sea stratum names. Strata A1, B1, C1, D1A, and D1B extended from the coast out to the 10 meter depth contour. Strata A2, B2, C2, and D2A, and D2B fell between the 10 and 20 meter depth contours; A3, B3, C3, and D3 fell between the 20 and 50 meter depth contours; etc. Strata D1A, D1B, D2A and D2B are enlarged in Figure B-5.

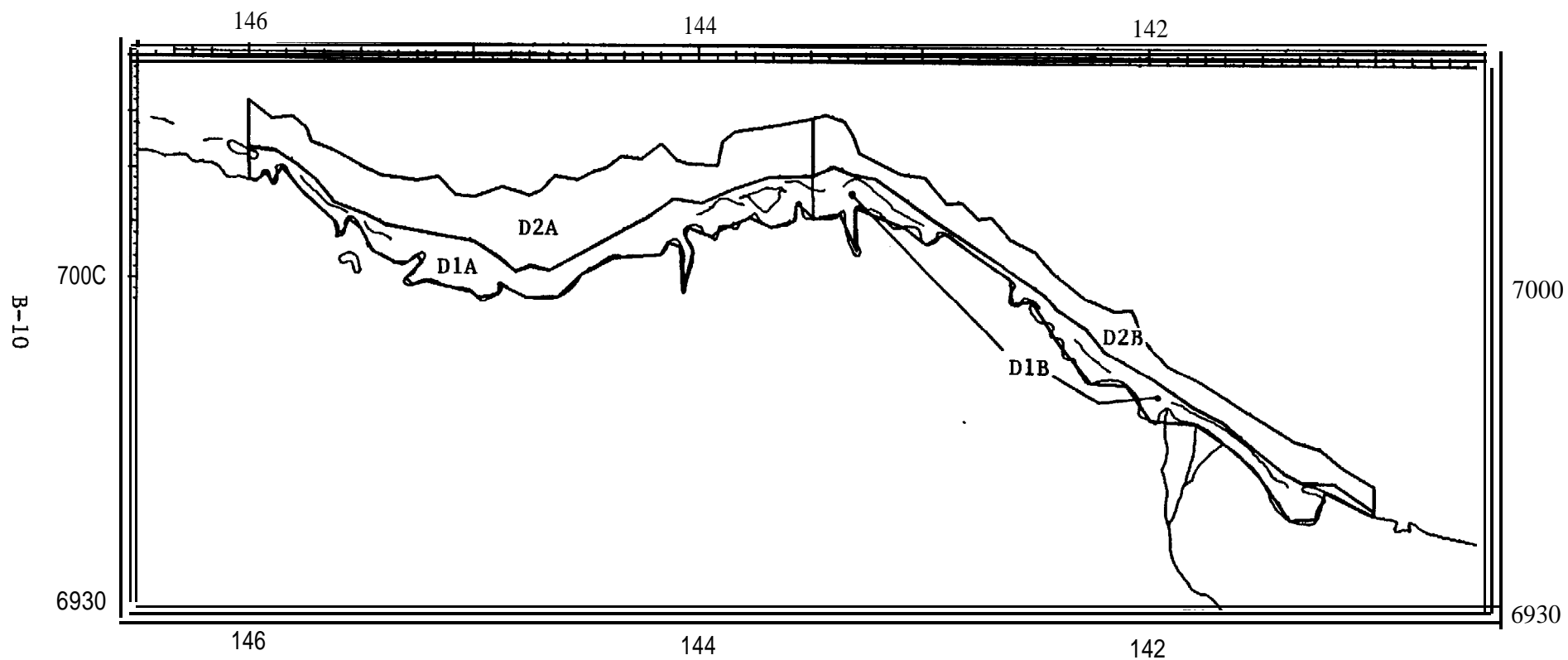


Figure B-5. Map depicting Beaufort Sea strata D1A, D1B, D2A, and D2B. Regions D1A and D1B extended from the coast out to the 10 meter depth contour. Regions D2A and D2B extended from the 10 meter to the 20 meter depth contour.

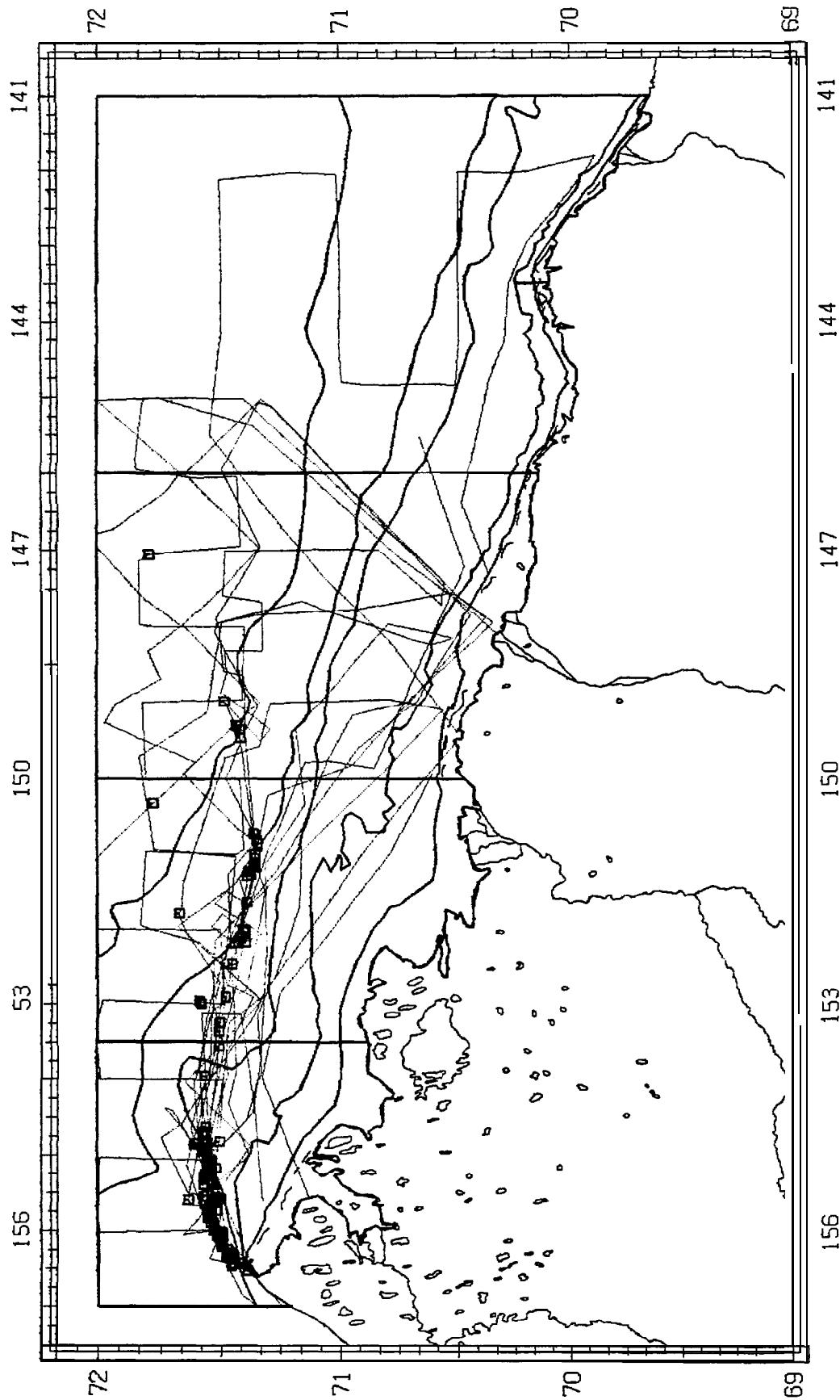


Figure B-6. Plot of aerial survey tracklines and bowhead whale sightings made during the May 1982 aerial survey of the Beaufort Sea.

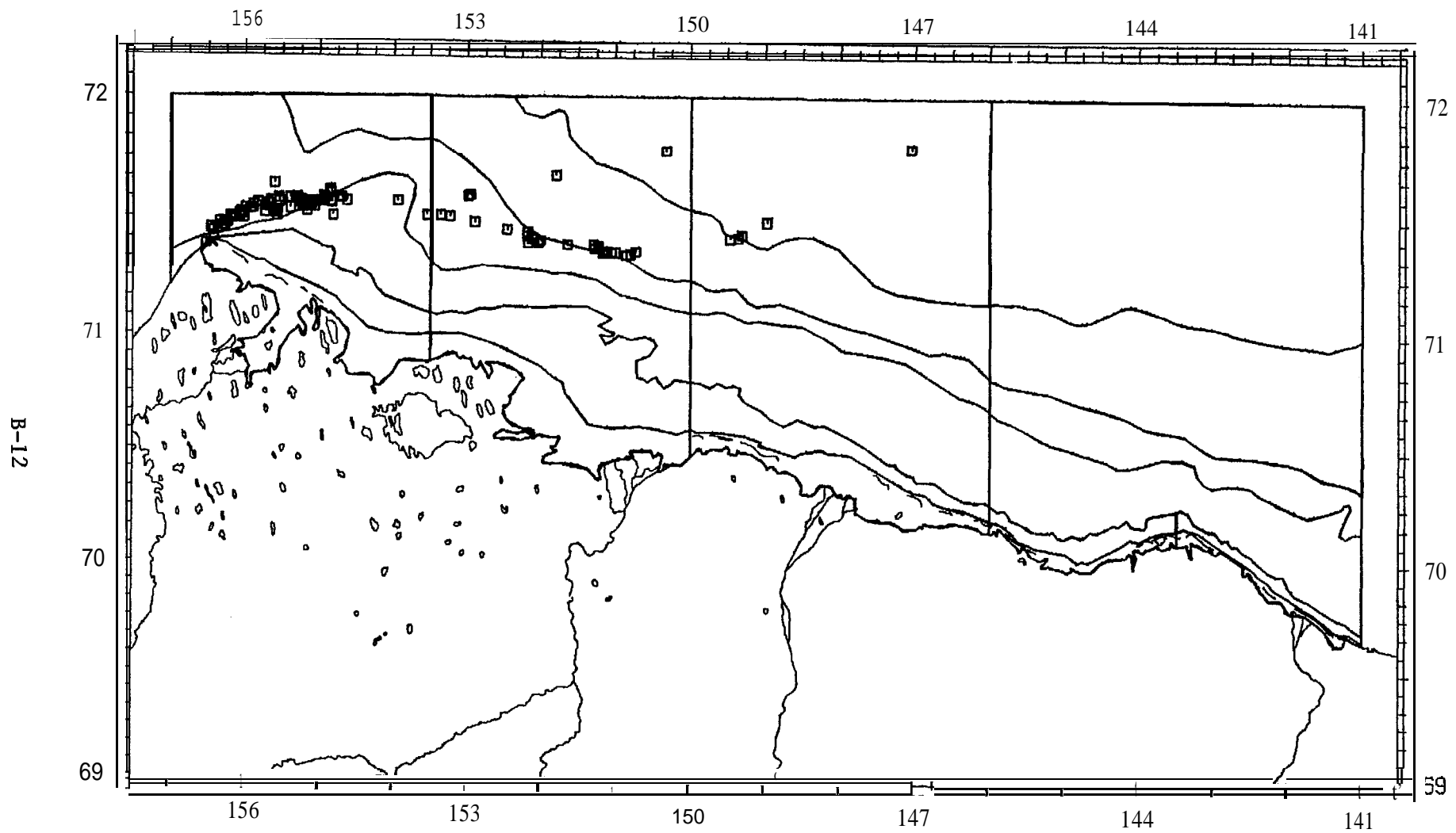
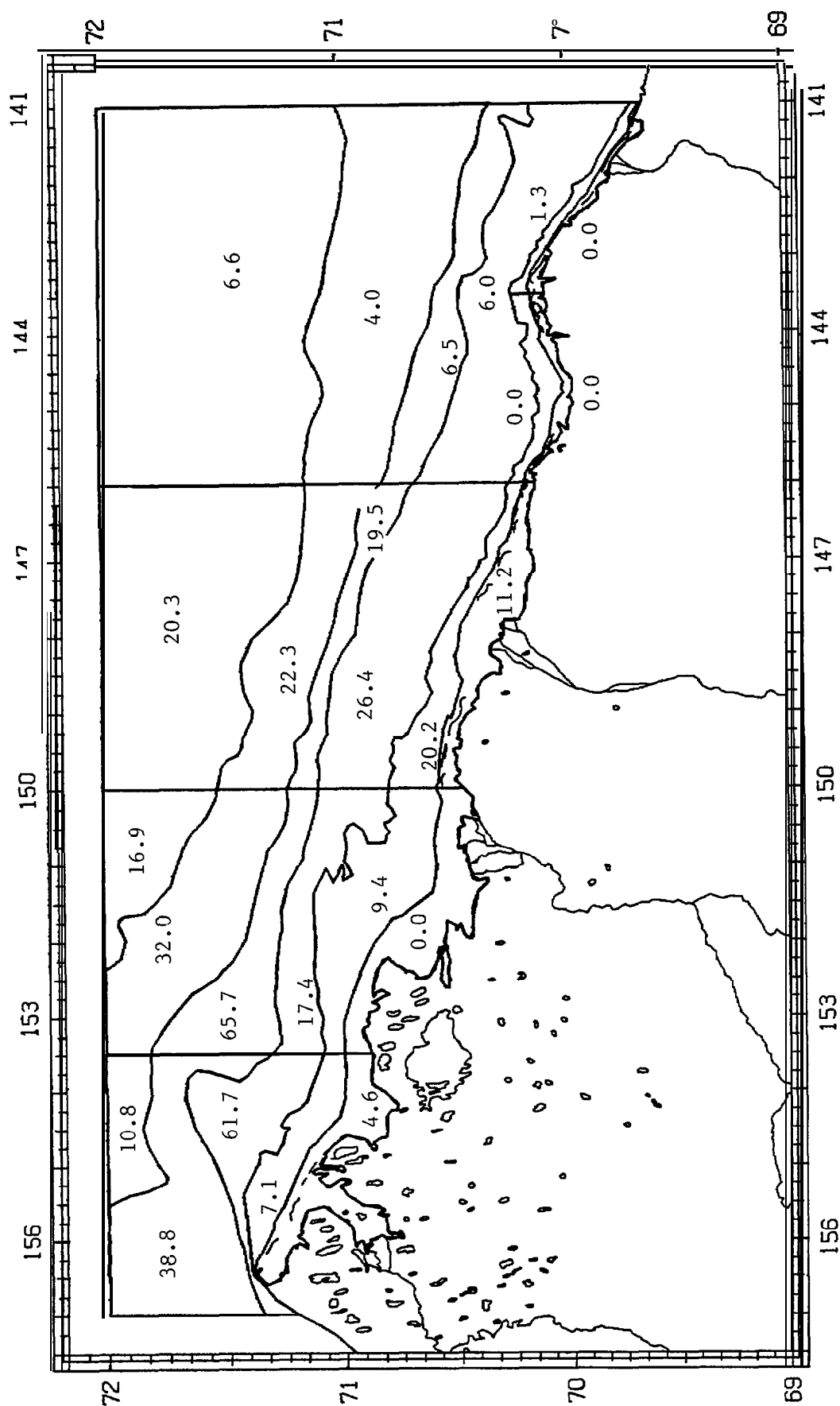


Figure B-7. Plot of bowhead whale sightings made during the May 1982 aerial survey of the Beaufort Sea.



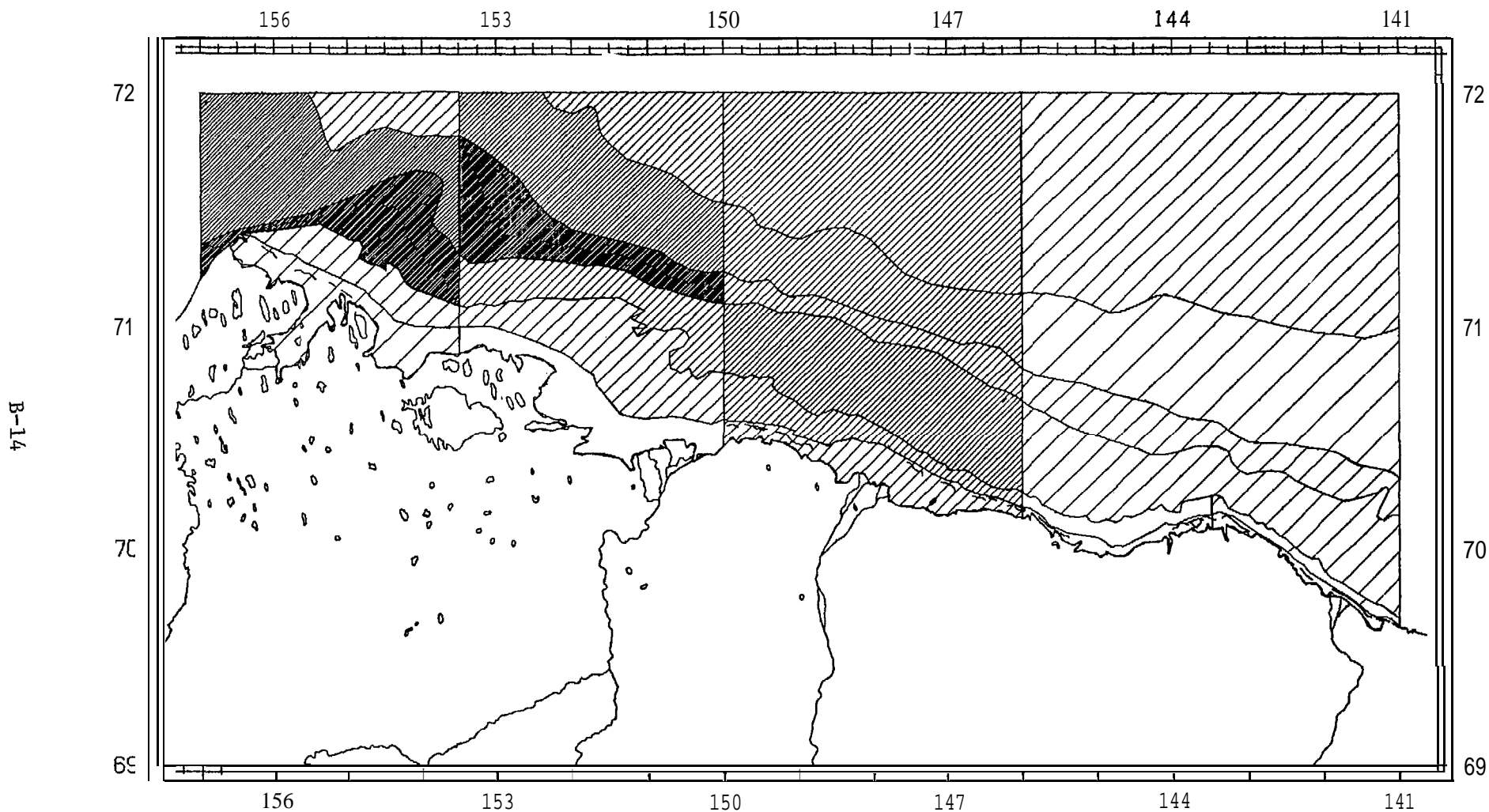


Figure B-8A. Shaded regions represent percentages expressed as total number of survey track miles flown divided by the area of each region. Shading varies from all white (representing 0 percent) to all black (representing 150 percent). Data are based on the May 1982 Beaufort Sea aerial surveys.

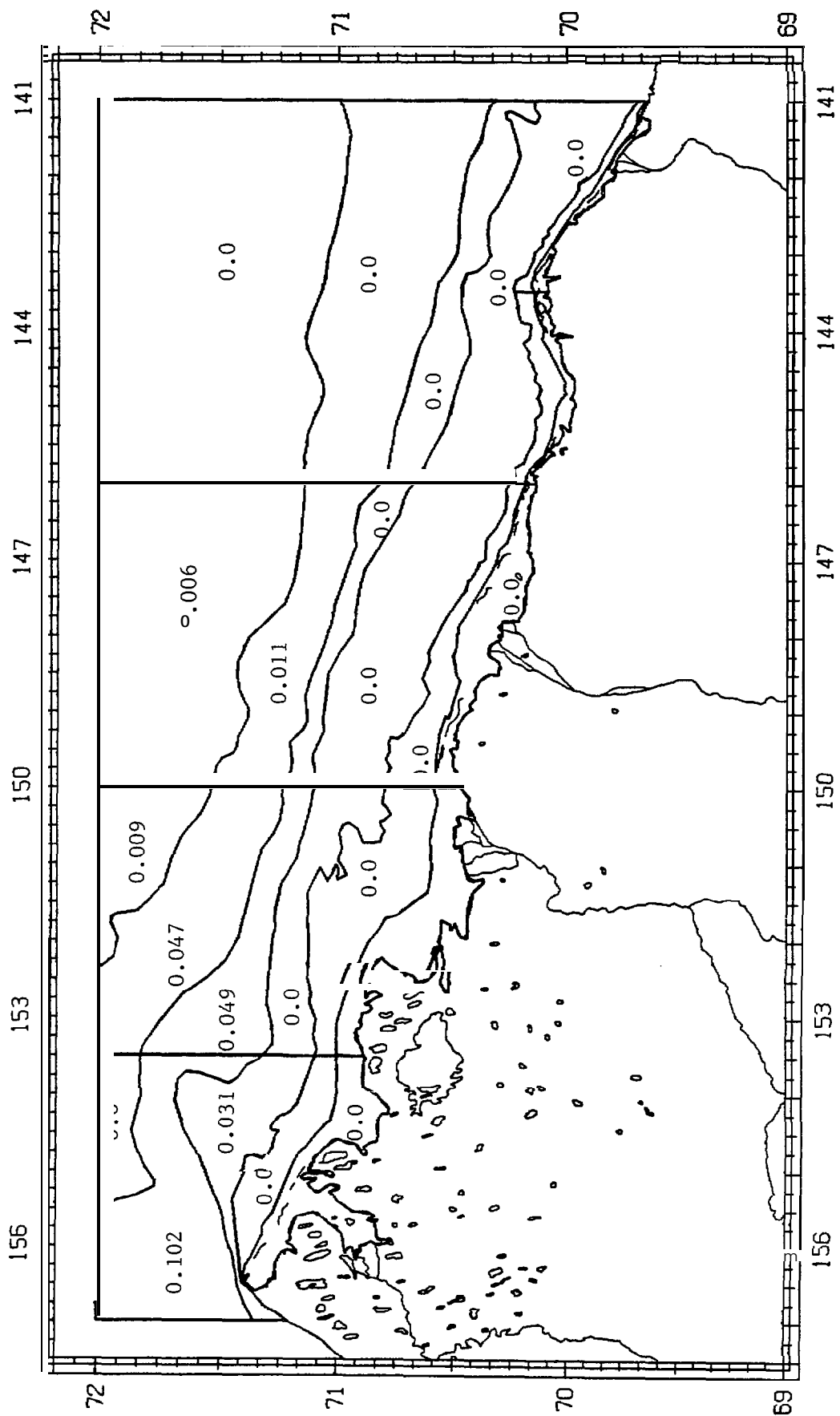


Figure B-9. Values shown are observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during May 1982.

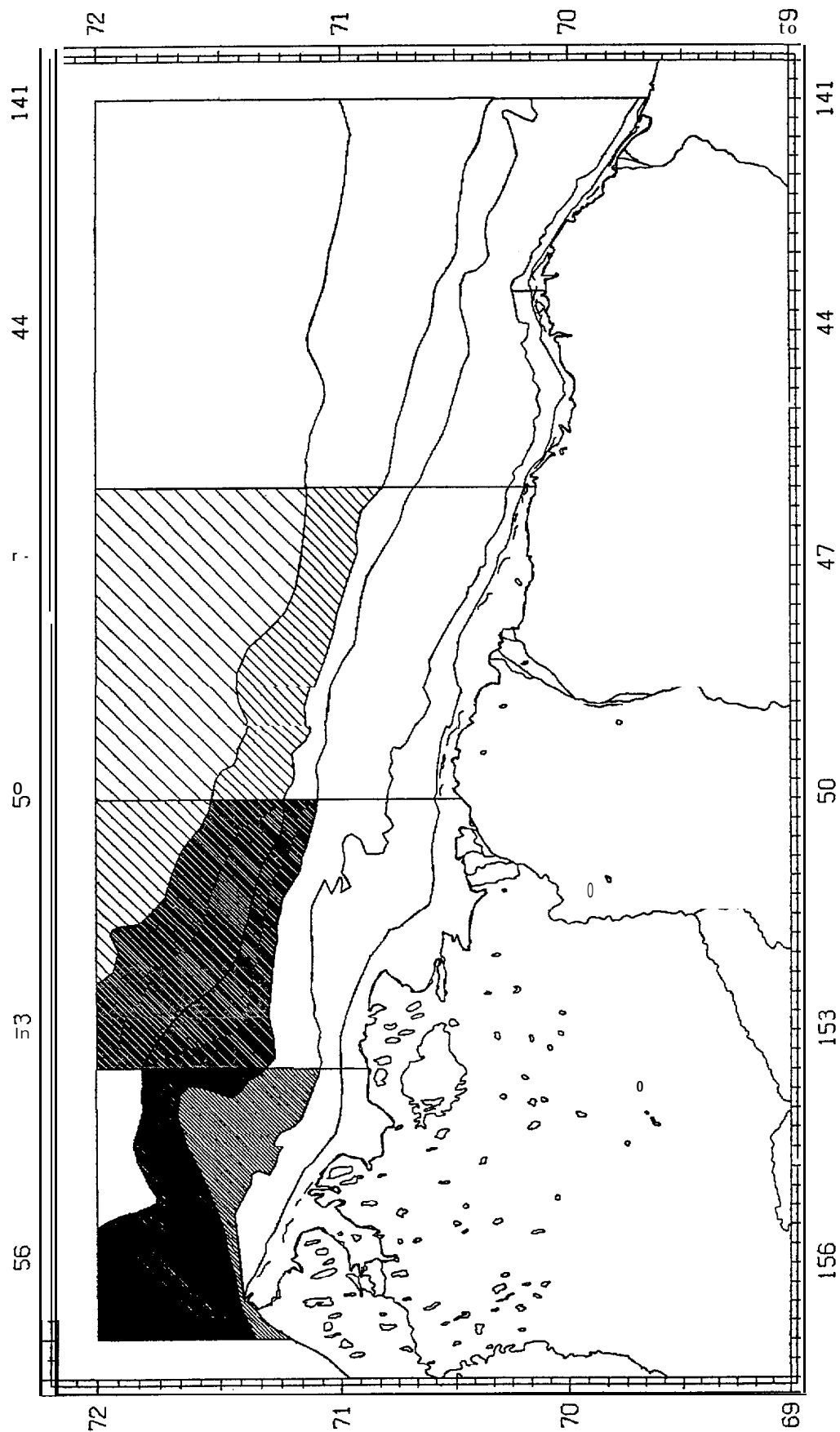


Figure B-9A. Shaded regions represent observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during May 1982. Shading varies from all white (representing 0 density) to all black (representing 0.110 density).

Table B-1. Statistics from aerial surveys of bowhead whales conducted May 1982 in the Beaufort Sea. Values for each region were summed where appropriate. Region numbers refer to areas depicted in figure B-4. The total area of all regions was approximately 29,070 nmi². Areas were approximated by straight line integration and thus minor discrepancies exist between the summation of areas of sub-regions and the area calculated for the total region. Total time spent surveying was approximately 46 hours.

Region Name	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Percent of total Time	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Variance Range of (#10 ⁻⁴)	Confidence Range of Density
Total	28,609	100.	17.13	46:02	100.00	29	134	0.027	> .6	0.002 - 0.053
A	3,792	3.	31.15	0:09	22.05	31	75	0.063	3.7	0.024 - 0.103
A1	654	2.25	4.62	0:4	0.51	10	0	0.0	0.0	0.0 - 0.0
A2	479	1.65	7.05	0:3	0.47	9	0	0.0	0.0	0.0 - 0.0
A3	789	2.71	61.67	3:5	8.15	33	15	0.031	2.9	0.0 - 0.065
A4	1,518	5.22	38.81	5:0	2.31	39	60	0.102	6.3	0.05 - 0.152
A5	384	1.32	0.78	0:6	0.58	2	0	0.0	0.0	0.0 - 0.0
B	5,569	19.	25.24	33	25.09	19	52	0.037	4.8	0.0 - 0.083
B1	739	2.54	0.0							
B2	1,079	3.71	9.38	0:47	1.70	3	0	0.0	0.0	0.0 - 0.0
B3	793	2.73	17.44	1:02	2.24	8	0	0.0	0.0	0.0 - 0.0
B4	893	3.07	65.66	4:53	10.61	23	29	0.049	13.8	0.0 - 0.126
B5	1,463	5.03	31.99	4:05	8.87	16	22	0.047	12.6	0.0 - 0.123
B6	659	2.27	16.93	0:46	1.67	5	1	0.009	0.2	0.0 - 0.023
C	7,701	27.	21.68	19:27	42.25	9	7	0.004	>0.0	0.0 - 0.003
C1	584	2.02	11.15	1:24	3.04	7	0	0.0	0.0	0.0 - 0.0
C2	528	1.82	20.23	3:45	8.15	13	0	0.0	0.0	0.0 - 0.0
C3	1,910	6.57	26.36	6:56	15.06	15	0	0.0	0.0	0.0 - 0.0
C4	486	1.67	19.48	0:46	1.67	13	0	0.0	0.0	0.0 - 0.0
C5	1,224	4.21	22.31	2:07	4.60	19	3	0.011	1.4	0.0 - 0.036
C6	3,070	10.56	20.33	4:27	9.67	15	4	0.006	0.7	0.0 - 0.024
D	11,625	41.	5.58	4:55	10.68	6	0	0.0	.	0.0 - 0.0
D1A	156	0.55	0.00							
D1B	123	0.42	0.00							
D2A	257	0.88	0.00							
D2B	155	0.53	1.26	0:02	0.07	1	0	0.0	0.0	0.0 - 0.0
D3	1,997	6.87	5.99	0:59	2.14	3	0	0.0	0.0	0.0 - 0.0
D4	1,018	3.50	6.48	0:26	0.94	3	0	0.0	0.0	0.0 - 0.0
D5	2,809	9.66	4.00	0:58	2.10	6	0	0.0	0.0	0.0 - 0.0
D6	5,303	8.24	6.57	2:29	5.39	5	0	0.0	0.0	0.0 - 0.0

Table B-2. Summary statistics from aerial survey of bowhead whales conducted April-May 1980 and 1981.
 Values for each region were taken from Tables B-1 and B-2, respectively (Ljungblad et al., 1982).

		1980				1981			
Region Name	Region Area nmi ²	Percent Of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²
Total	28,609	11.18	28	268	0.084	19.27	22	271	0.049
A	3,792	36.05	26	175	0.128	33.51	15	100	0.079
A1	654	12.68	15	0	0.0	0.74	2	0	0.0
A2	479	7.13	9	0	0.0	1.39	2	0	0.0
A3	789	47.12	35	58	0.156	83.77	25	42	0.064
A4	1,518	54.49	36	117	0.141	38.24	35	53	0.091
A5	384	12.81	6	0	0.0	5.07	2	5	0.256
B	5,569	14.40	11	58	0.072	38.5	26	150	0.070
B1	739	6.12	2	0	0.0	7.57	2	0	0.0
B2	1,079	2.35	2	0	0.0	15.60	9	0	0.0
B3	793	3.06	3	0	0.0	16.74	14	0	0.0
B4	893	42.80	15	25	0.065	87.22	34	56	0.072
B5	1,463	22.15	11	33	0.102	68.10	23	93	0.093
B6	659	0.00	0	0	0.0	5.33	4	1	0.028
c	7,701	7.28	11	24	0.043	19.38	26	13	0.009
c1	584	14.90	6	0	0.0	2.64	3	0	0.0
C2	528	10.64	7	0	0.0	15.41	9	0	0.0
C3	1,910	5.76	7	0	0.0	12.67	15	0	0.0
C4	486	10.77	5	0	0.0	26.95	16	0	0.0
C5	1,224	9.13	6	1	0.009	50.94	27	6	0.010
C6	3,070	4.66	4	23	0.161	12.90	13	7	0.018
D	11,625	4.07	4	11	0.023	5.37	11	8	0.013
D1A	156	2.31	1	0	0.0	2.96	1	0	0.0
D1B	123	0.00				12.26	4	0	0.0
D2A	257	8.50	4	0	0.0	2.11	1	0	0.0
D2B	155	2.33	2	0	0.0	24.88	3	0	0.0
D3	1,997	7.30	4	0	0.0	4.79	6	0	0.0
D4	1,018	1.64	2	0	0.0	5.26	4	0	0.0
D5	2,809	3.16	2	1	0.011	8.32	7	7	0.030
D6	5,303	3.65	4	10	0.052	3.34	5	1	0.006

The highest bowhead density in May 1982 was calculated for subregion A4 (Table B-1). In 1981 and 1980 subregions A5 and A3 showed highest densities, respectively, for the period April-May. Thus, in region A during this period bowhead densities appear to be annually variable in waters deeper than 20 m.

In region B, subregions B4 and B5 showed highest densities for May 1982, with subregion B5 the area of greatest density in 1981 and 1980 (Table B-2). Similarity in region C offshore subregions C5 and C6 show highest densities for 1980 through 1982. These areas correspond roughly to the shelf break where depth changes rapidly from about 50 m to over 2000 m. The distribution of bowhead sightings in regions B and C has centered along the 71°30'N latitude line each spring corresponding to an ice transition zone where pack ice shears along shorefast ice, over the shelf break. It is in this transition zone that bowheads find enough open water cracks and ponds to permit migration.

No whales were seen in region D in 1982. The few whales seen in 1981 and 1980 were in subregions D5 and D6 in water 200 m. deep or greater. Heavy ice conditions in this region each spring precludes many sightings there.

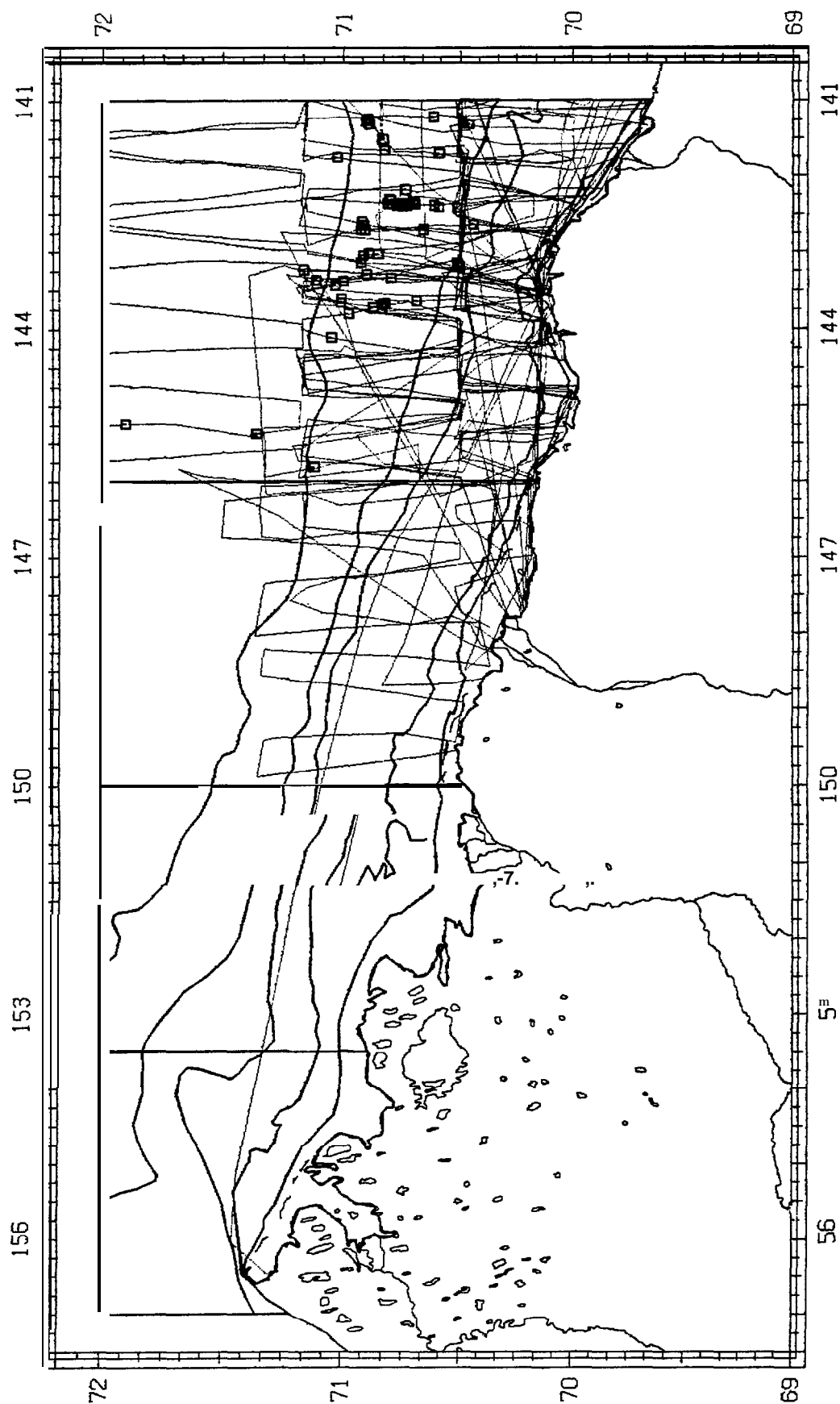


Figure B-10. Plot of aerial survey tracklines and bowhead whale sightings made during the August 1982 aerial survey of the Beaufort Sea.

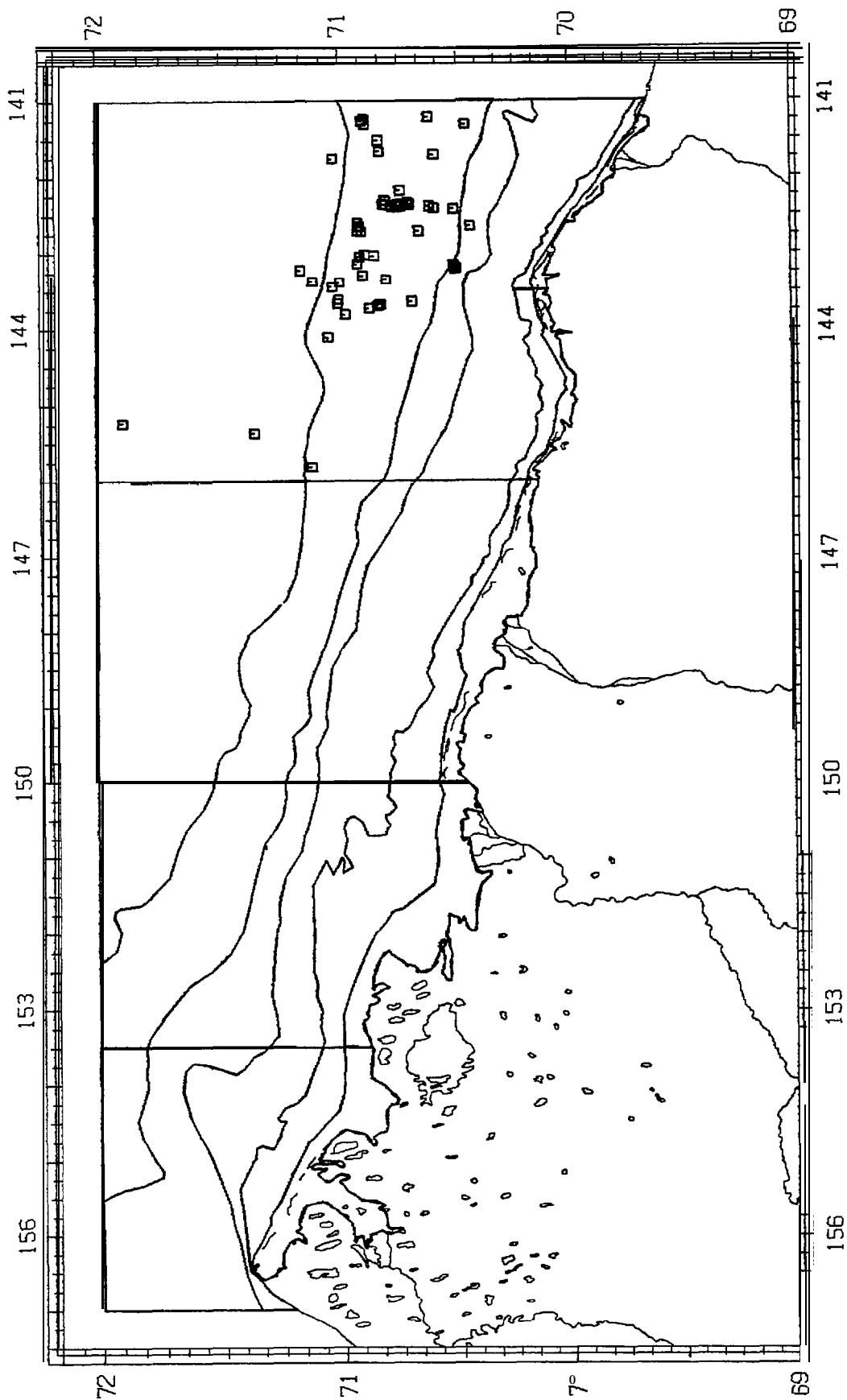


Figure B-11. Plot of bowhead whale sightings during the August 1982 aerial survey of the Beaufort Sea.

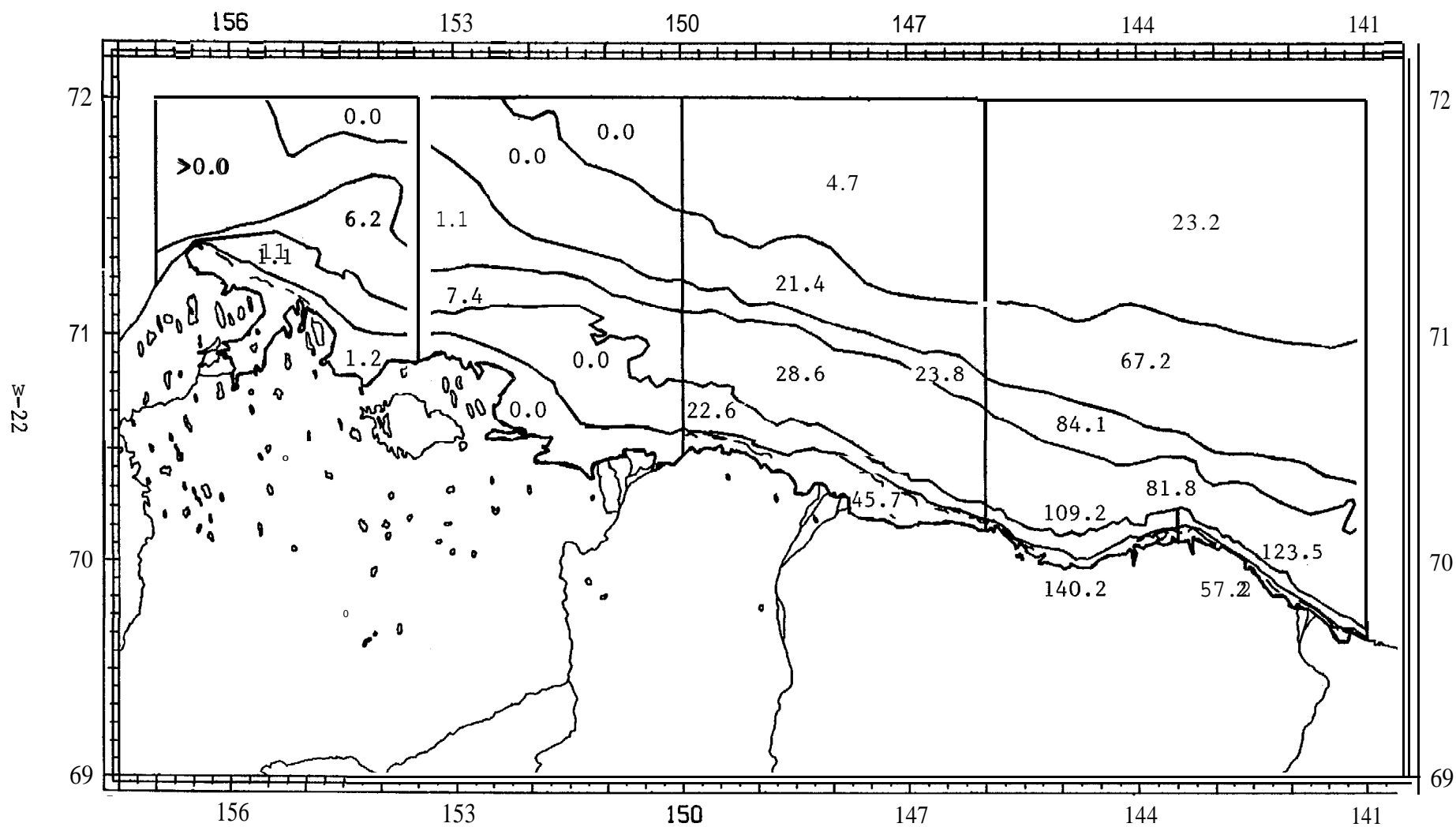


Figure B-12. Values shown are percentages expressed as total number of survey track miles flown divided by the area of each region. Values exceeding 100 percent resulted when the total number of nautical miles surveyed was greater than the region, indicating that some locations were overflown more than once. Data are based on the August 1982 Beaufort Sea aerial surveys.

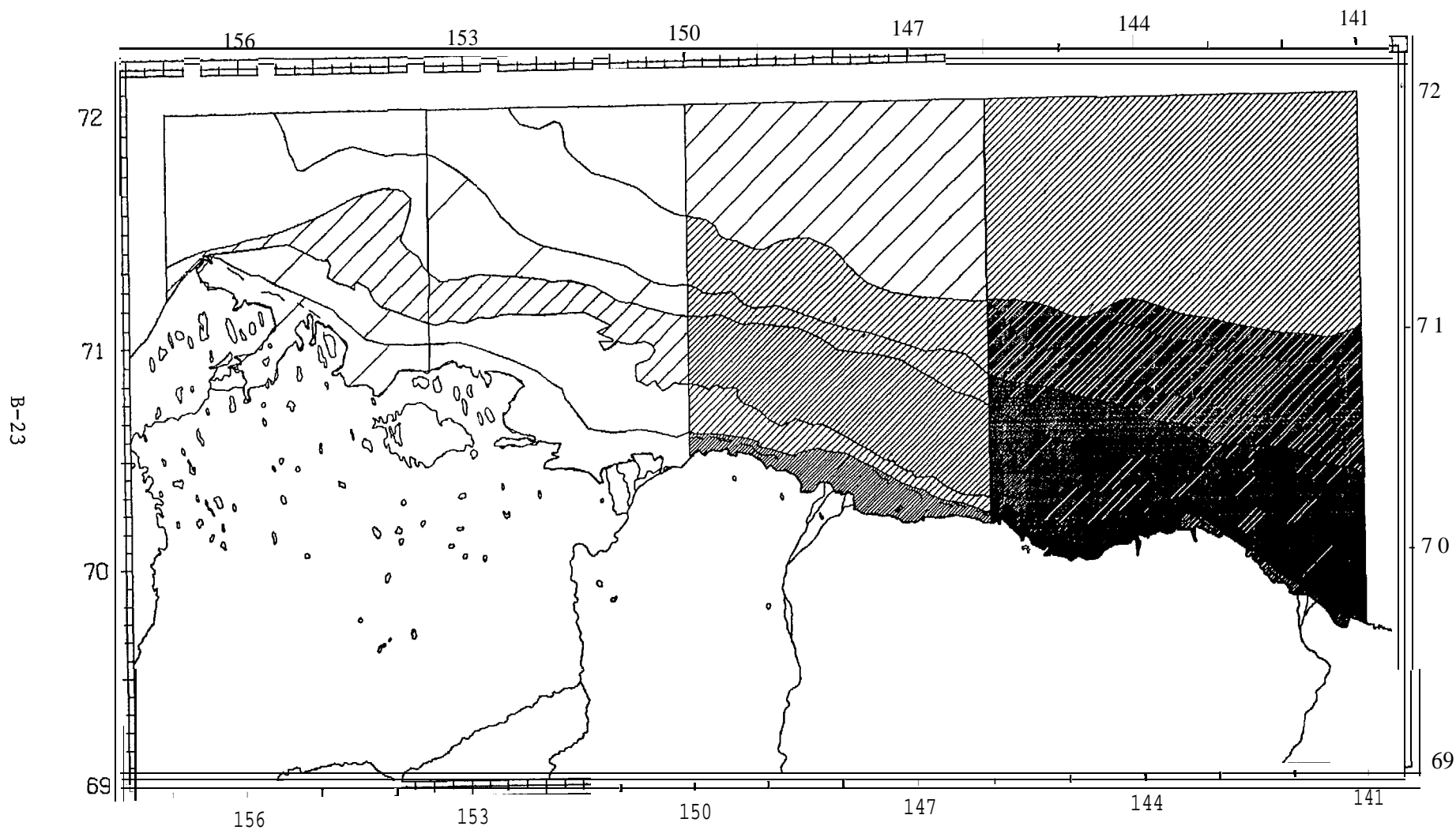


Figure B-12A. Shaded regions represent percentages expressed as total number of survey track miles flown divided by the area of each region. Shading varies from all white (representing 0 percent) to all black (representing 150 percent). Data are based on the August 1982 Beaufort Sea aerial surveys.

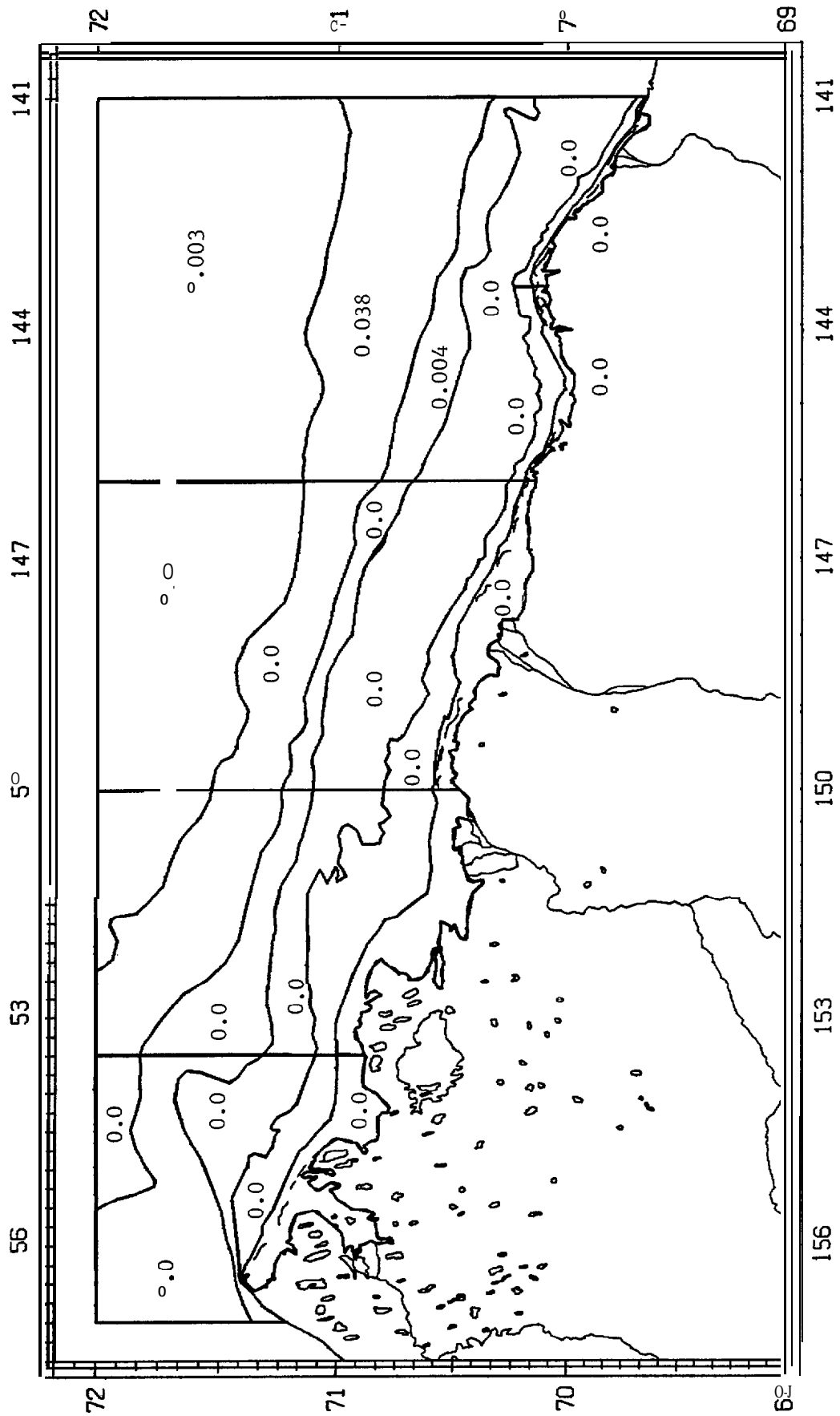


Figure B-13. Values shown are observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during August 1982.

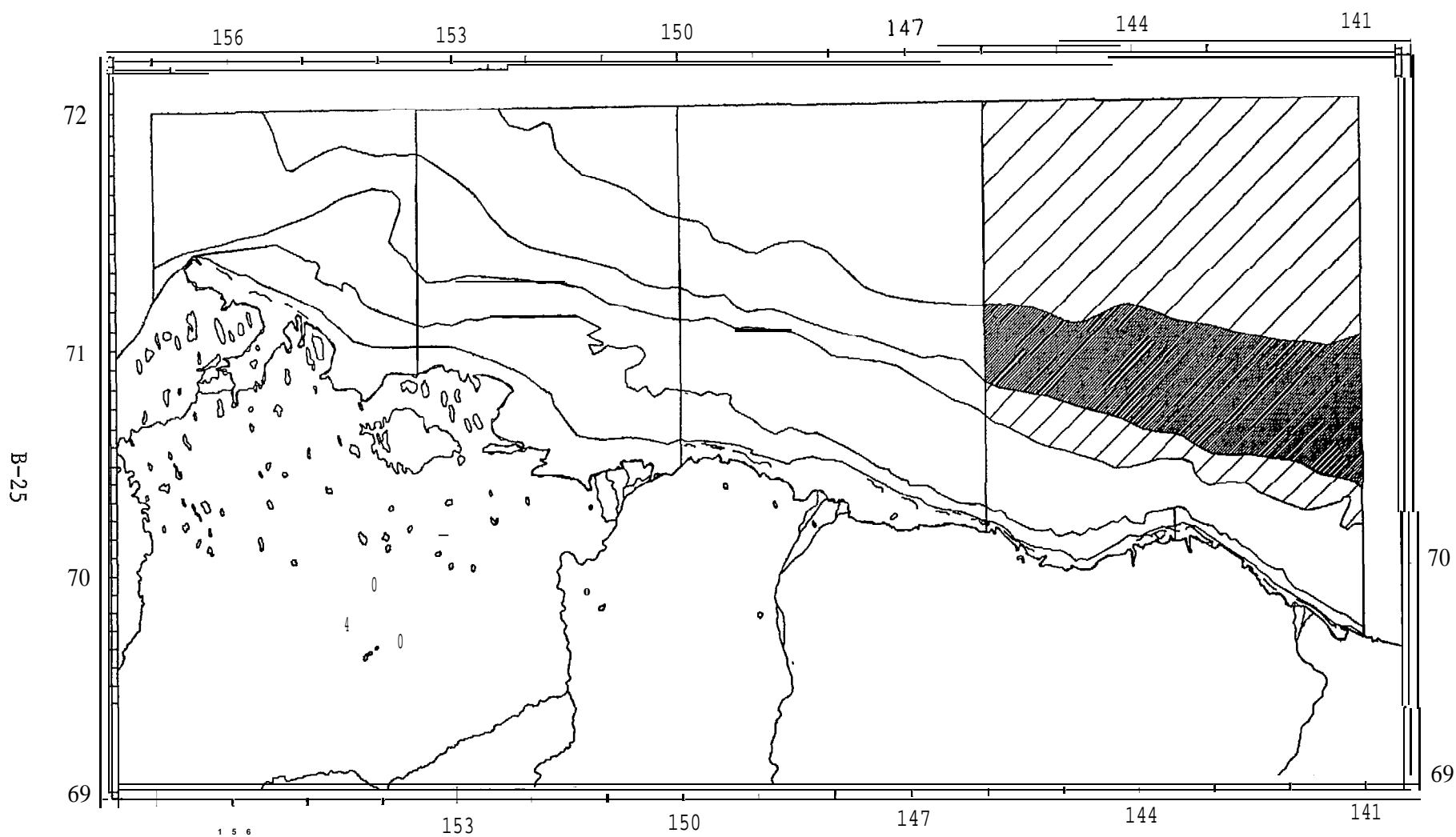


Figure B-13A. Shaded regions represent observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during August 1982. Shading varies from all white (representing 0 density) to all black (representing 0.110 density).

Table B-3. Statistics from aerial surveys of bowhead whales conducted August 1982 in the Beaufort Sea. Values for each region were summed where appropriate. Region numbers refer to areas depicted in Figure B-4. The total area of all regions was approximately 29,070 nmi². Areas were approximated by straight line integration and thus minor discrepancies exist between the summation of areas of sub-regions and the area calculated for the total region. Total time spent surveying was approximately 69 hours.

Region Name	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Percent of total Time	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Variance (*10 ⁻⁴)	Confidence Range of Density
Total	28,609	100.	27.78	68:48	100.00	313	79	0.010	0.2	0.002 - 0.018
A	3,792	13.	1.65	0:22	0.53	1	0	0.0	0.0	0.0 - 0.0
A1	654	2.25	1.17	0:03	0.07	1	0	0.0	0.0	0.0 - 0.0
A2	479	1.65	1.12	0:02	0.05	2	0	0.0	0.0	0.0 - 0.0
A3	789	2.71	6.23	0:17	0.41	2	0	0.0	0.0	0.0 - 0.0
A4	1,518	5.22	0.04	<0:01	>0.00	1	0	0.0	0.0	0.0 - 0.0
A5	384	1.32	0.0							
B	5,569	19.	1.24	0:25	0.61	1	0	0.0	0.0	0.0 - 0.0
B1	739	2.54	0.0							
B2	1,079	3.71	0.0							
B3	793	2.73	7.44	0:21	0.51	1	0	0.0	0.0	0.0 - 0.0
B4	893	3.07	1.14	0:04	0.10	1	0	0.0	0.0	0.0 - 0.0
B5	1,463	5.03	0.0							
B6	659	2.27	0.0							
C	7,701	27.	18.86	13:47	20.03	55	0	0.0	0.0	0.0 - 0.0
C1	584	2.02	45.68	5:26	7.90	31	0	0.0	0.0	0.0 - 0.0
C2	528	1.82	22.62	0:53	1.28	23	0	0.0	0.0	0.0 - 0.0
C3	1,910	6.57	28.61	3:50	5.57	31	0	0.0	0.0	0.0 - 0.0
C4	486	1.67	23.77	0:49	1.19	18	0	0.0	0.0	0.0 - 0.0
C5	1,224	4.21	21.41	1:52	2.71	22	0	0.0	0.0	0.0 - 0.0
C6	3,070	10.56	4.68	0:58	1.41	12	0	0.0	0.0	0.0 - 0.0
D	11,625	41.	54.80	54:17	78.90	281	79	0.012	0.2	0.003 - 0.021
D1A	156	0.55	140.15	3:05	4.48	63	0	0.0	0.0	0.0 - 0.0
D1B	123	0.42	57.24	0:39	0.94	22	0	0.0	0.0	0.0 - 0.0
D2A	257	0.88	109.22	3:11	4.63	47	0	0.0	0.0	0.0 - 0.0
D2B	155	0.53	123.46	1:29	2.16	40	0	0.0	0.0	0.0 - 0.0
D3	1,997	6.87	81.76	12:33	18.24	120	0	0.0	0.0	0.0 - 0.0
D4	1,018	3.50	84.05	6:32	9.50	115	3	0.004	0.3	0.0 - 0.014
D5	2,809	9.66	67.16	17:05	24.83	114	72	0.038	2.0	0.010 - 0.066
D6	5,303	18.24	23.14	9:41	14.07	94	4	0.003	>0.0	0.0 - 0.007

Table B-4. Summary statistics from aerial surveys of bowhead whales conducted August 1979, and June-August 1980 and 1981. Values for each region were taken from Tables B-3, B-4 and B-5, respectively (Ljungblad et al. , 1982) .

Region Name	Region Area nmi ²	1979				1980				1981			
		Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²
Total	28,609	14.43	25	7	0.002	38.74	78	16	0.001	8.67	27	0	0.0
A	3,792	0.00				12.57	14	0	0.0	11.26	12	0	0.0
A1	654	0.00				19.22	14	0	0.0	10.28	8	0	0.0
A2	479	0.00				31.93	12	0	0.0	26.51	7	0	0.0
A3	789	0.00				14.70	12	0	0.0	18.01	12	0	0.0
A4	1,518	0.00				4.44	5	0	0.0	6.73	5	0	0.0
AS	384	0.00				4.15	1	0	0.0	0.00			
B	5,569	0.00				50.87	50	0	0.0	11.69	8	0	0.0
B1	739	0.00				88.56	54	0	0.0	17.55	6	0	0.0
B2	1,079	0.00				92.33	52	0	0.0	17.97	12	0	0.0
B3	793	0.00				64.90	47	0	0.0	21.41	9	0	0.0
B4	892	0.00				35.46	25	0	0.0	9.32	4	0	0.0
B5	1,463	0.00				17.12	11	0	0.0	5.07	2	0	0.0
B6	659	0.00				15.09	6	0	0.0	0.0			
c	7,701	30.37	23	0	0.0	71.90	64	2	0.0	11.02	19	0	0.0
c1	584	134.72	49	0	0.0	154.26	76	0	>0.0	45.51	16	0	0.0
C2	528	69.03	68	0	0.0	173.56	99	0	0.0	44.85	18	0	0.0
C3	1,910	54.49	42	0	0.0	104.06	76	0	0.0	10.29	13	0	0.0
C4	486	8.73	7	0	0.0	44.53	29	0	0.0	2.06	2	0	0.0
C5	1,224	7.82	8	0	0.0	35.00	27	0	0.0	3.73	4	0	0.0
C6	3,070	2.58	5	0	0.0	35.08	21	2	0.002	3.05	3	0	0.0
D	11,625	15.40	19	7	0.004	19.29	23	14	0.006	4.74	10	0	0.0
D1A	156	15.04	11	0	0.0	13.76	4	0	0.0	1.79	1		
D1B	123	0.00				11.15	4	0	0.0	3.93	1		
D2A	257	112.04	34	0	0.0	5.57	5	0	0.0	17.43	8	0	0.0
D2B	155	9.6B	3	0	0.0	14.25	4	0	0.0	7.29	4	0	0.0
D3	1,997	44.53	46	0	0.0	25.49	16	0	0.0	21.83	12	0	0.0
D4	1,018	31.73	24	4	0.012	7.32	7	0	0.0	0.00			
D5	2,809	7.05	8	3	0.015	10.14	11	0	0.0	1.84	1	0	0.0
D6	5,303	0.00	0	0	0.0	24.51	11	14	0.011	0.00	0		

The highest bowhead density in August 1982 was calculated for sub-region D5 (Table B-3). In 1981 no bowheads were seen in the Beaufort Sea in August, while in 1980 and 1979 whales were found in subregions D6 and D4 and D5, respectively (Table B-4). Varied August survey effort over the years precluded good density comparisons. In general, bowheads in August have been seen in region D in water 50 m. or deeper, with most sightings in water greater than 200 m. depth. Further August surveys may delineate bowhead use of this area.

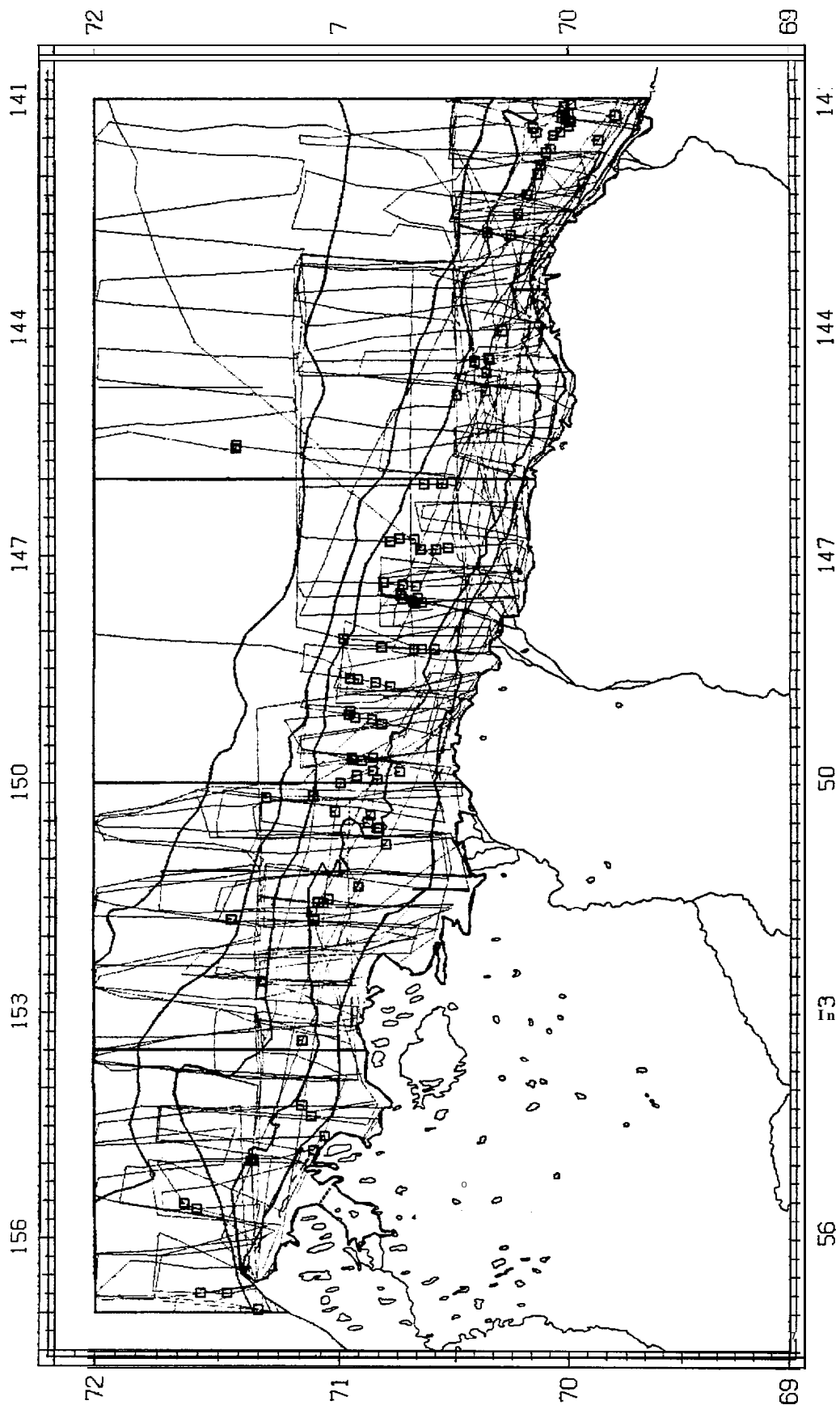


Figure B-14. Plot of aerial survey tracklines and bowhead whale sightings made during the September-October 1982 aerial survey of the Beaufort Sea.

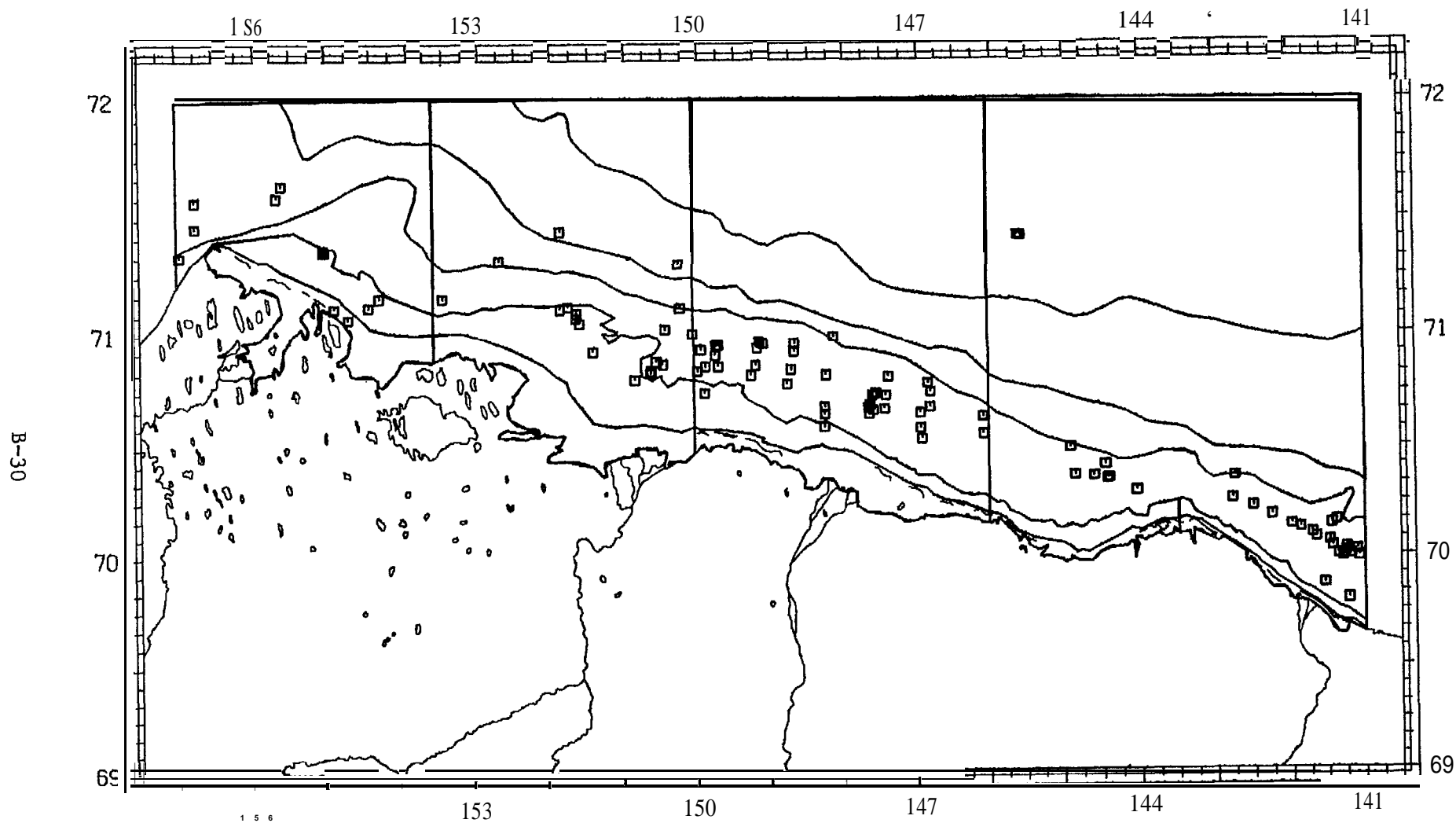


Figure B-15. Plot of bowhead whale sightings made during the September-October 1982 aerial survey of the Beaufort Sea.

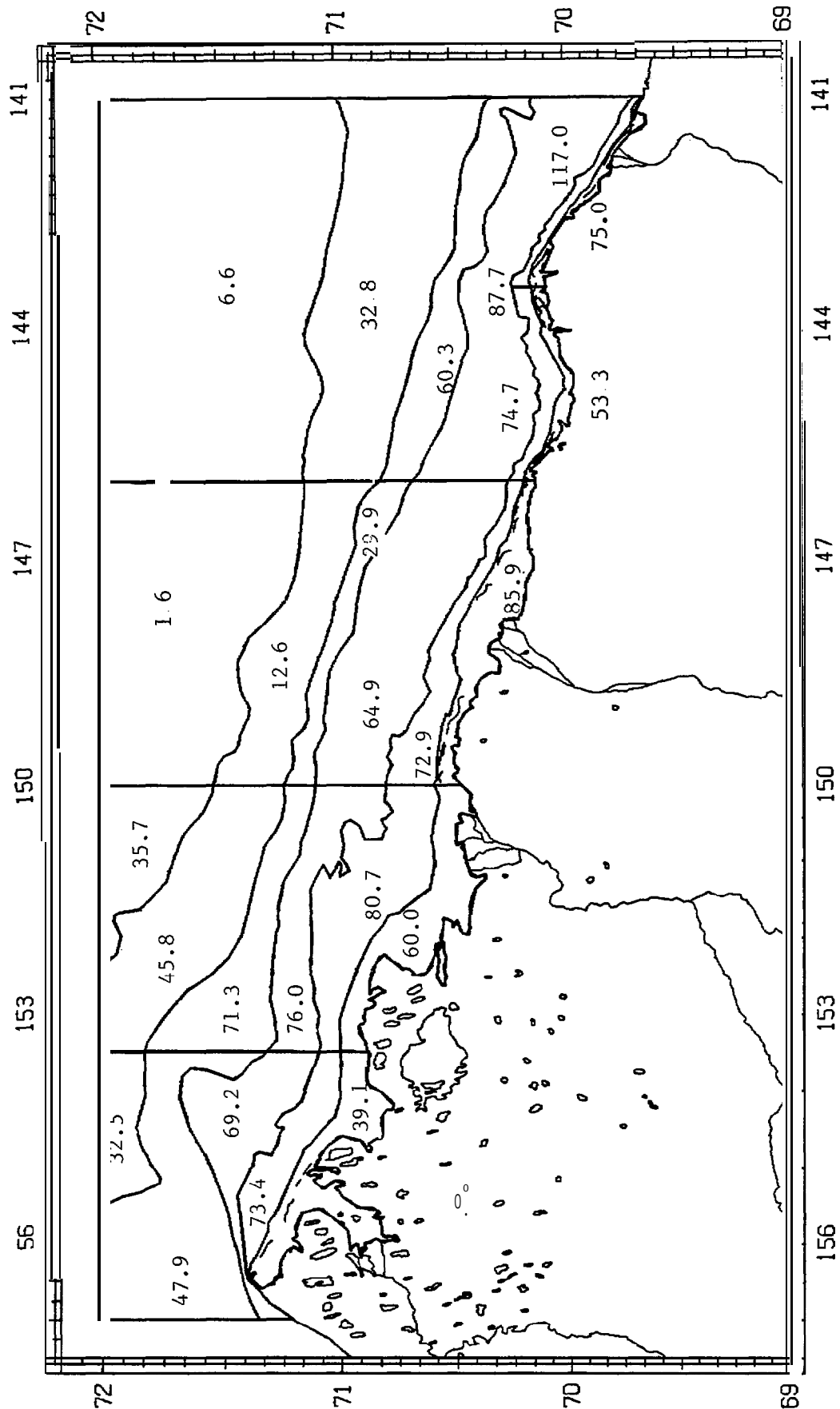


Figure B-16. Values shown are percentages expressed as total number of survey track miles flow divided by the area of each region. Values exceeding 100 percent resulted when the total number of nautical miles surveyed was greater than the region, indicating that some locations were overflown more than once. Data are based on the September-October 1982 Beaufort Sea aerial surveys.

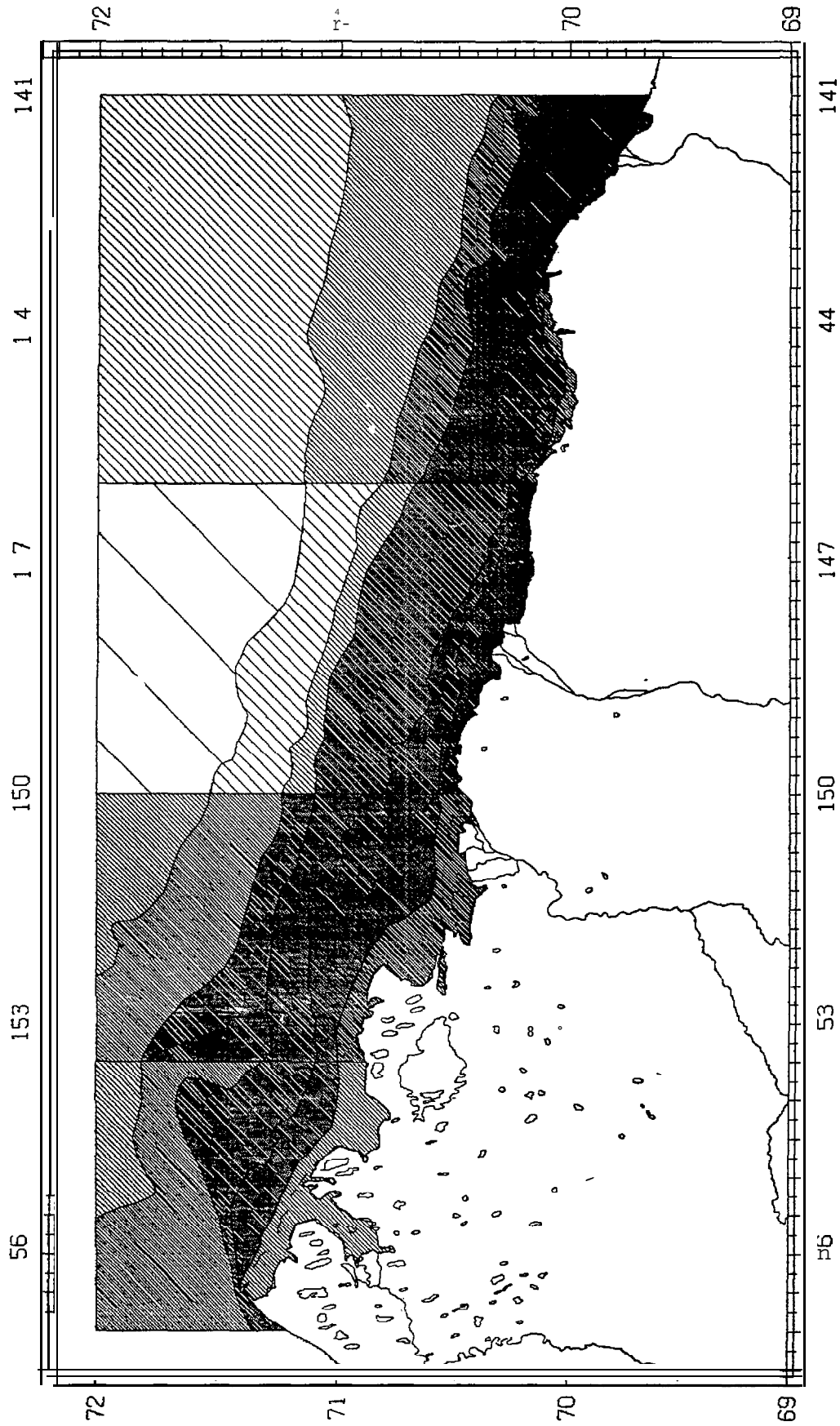


Figure B-16A. Shaded regions represent percentages expressed as total number of survey track miles flown divided by the area of each region. Shading varies from all white (representing 0 percent) to all black (representing 150 percent). Data are based on the September-October 1982 Beaufort Sea aerial surveys.

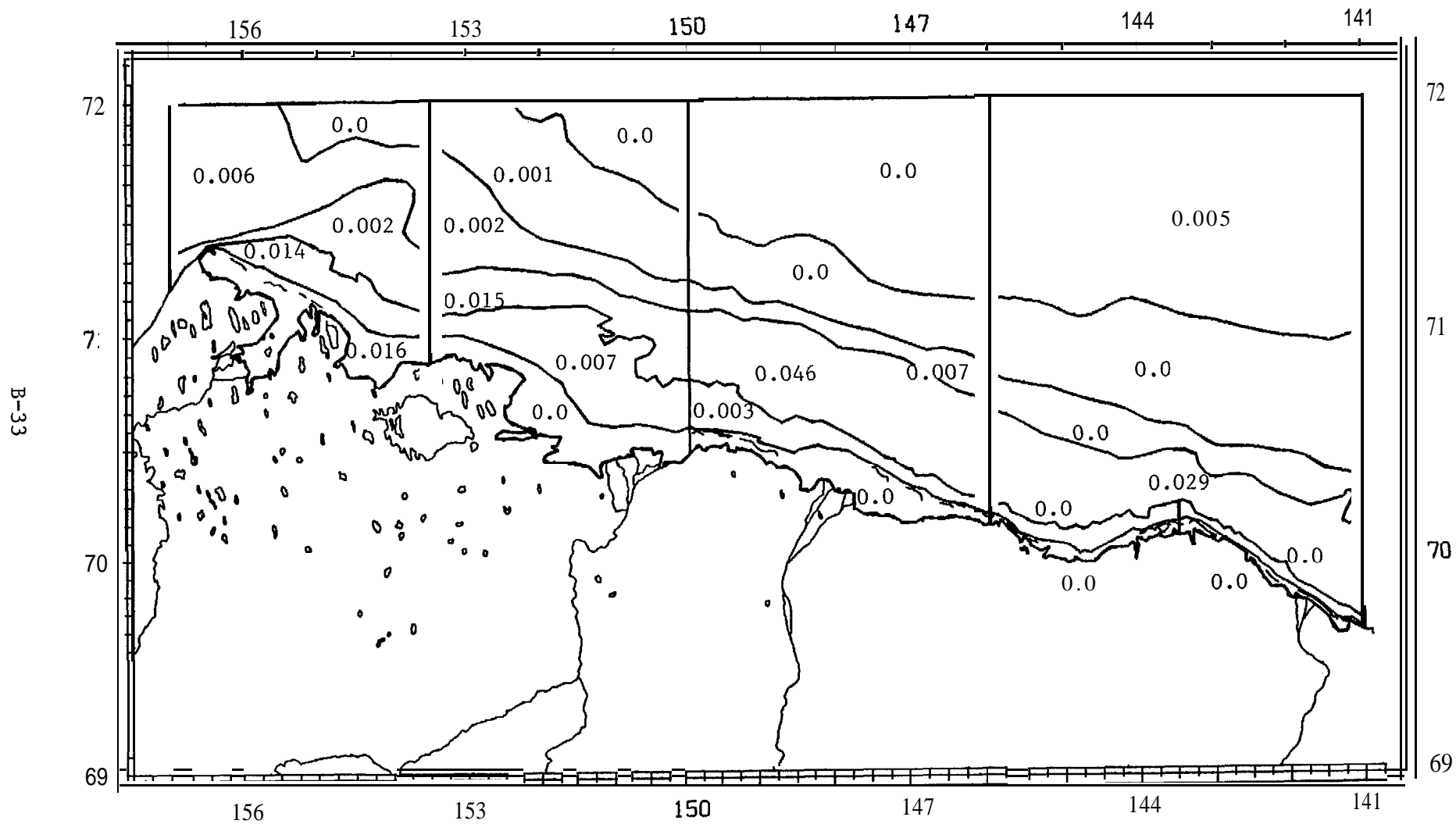


Figure B-17. Values shown are observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during September-October 1982.

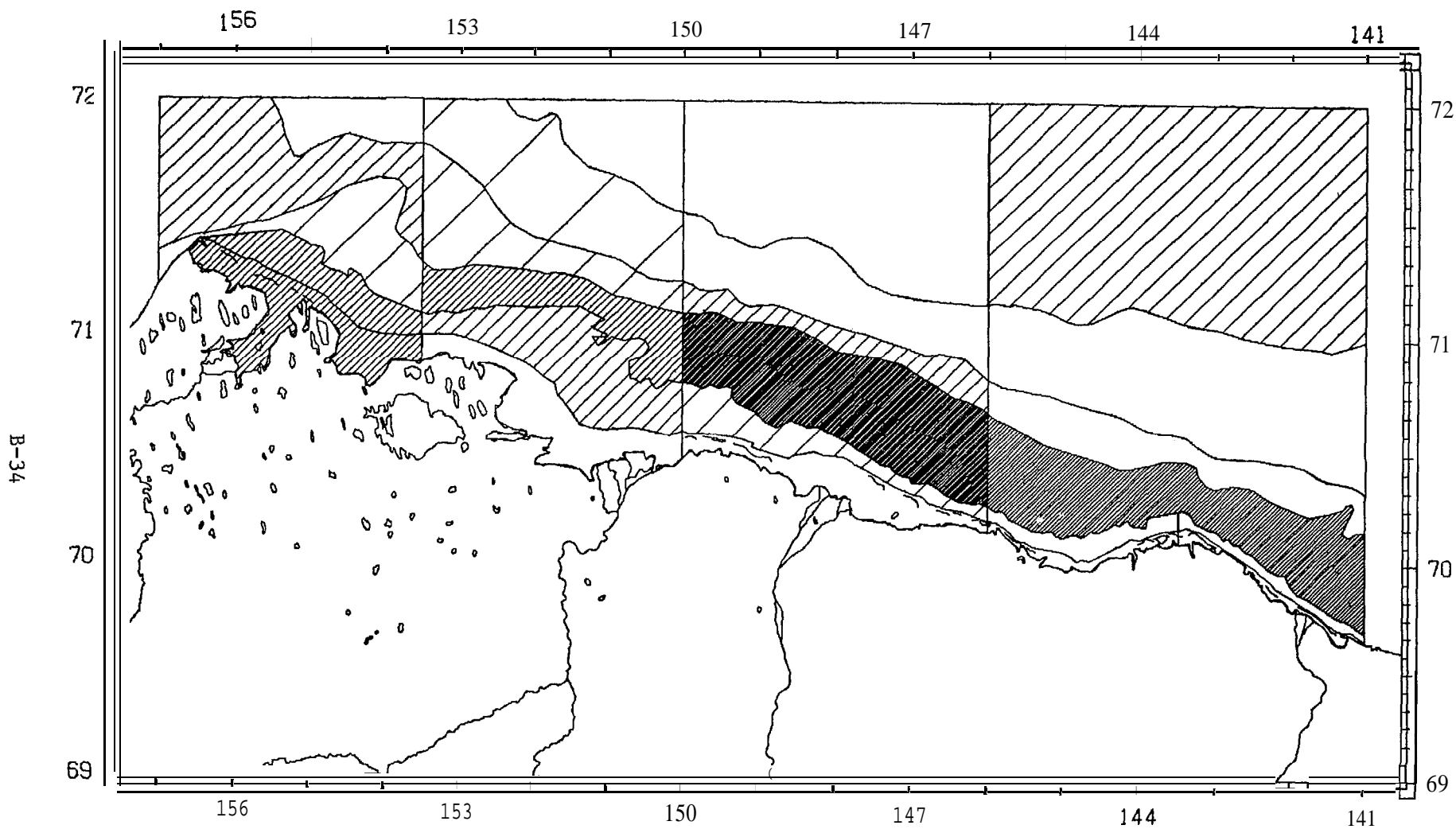


Figure B-17A. Shaded regions represent observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during September-October 1982. Shading varies from all white (representing 0 density) to all black (representing 0.110 density).

Table B-5. Statistics from aerial surveys of bowhead whales conducted September-October 1982 in the Beaufort Sea. Values for each region were summed where appropriate. Region numbers refer to areas depicted in Figure B-4. The total area of all regions was approximately 29,070 nmi². Areas were approximated by straight line integration and thus minor discrepancies exist between the summation of areas of sub-regions and the area calculated for the total region. Total time spent surveying was approximately 95 hours.

Region Name	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Percent of total Time	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Variance (x10 ⁻⁴)	Confidence Range of Density
Total	28,609	100.	44.21	95:25	100.00	450	145	0.011	0.1	0.007 - 0.016
A	3,792	13.	52.85	15:21	16.09	94	14	0.007	0.1	0.001 - 0.013
A1	654	2.25	39.07	2:50	2.97	43	4	0.016	1.7	0.0 - 0.042
A2	479	1.65	73.39	2:19	2.43	41	5	0.014	0.4	0.002 - 0.027
A3	789	2.71	69.17	3:44	3.91	58	1	0.002	0.1	0.0 - 0.007
A4	1,518	5.22	47.85	5:33	5.82	61	4	0.006	0.1	0.001 - 0.010
A5	384	1.32	32.52	0:56	0.98	19	0	0.0	0.0	0.0 - 0.0
B	5,569	19.	62.06	25:22	26.59	130	17	0.005	>0.0	0.002 - 0.008
B1	739	2.54	59.95	3:17	3.44	58	0	0.0	0.0	0.0 - 0.0
B2	1,079	3.71	80.66	6:27	6.76	75	6	0.007	>0.0	0.002 - 0.011
B3	793	2.73	75.98	4:21	4.56	69	9	0.015	1.6	0.0 - 0.041
B4	893	3.07	71.34	4:46	5.00	76	1	0.002	>0.0	0.0 - 0.003
B5	1,463	5.03	45.80	4:50	5.07	55	1	0.001	>0.0	0.0 - 0.003
B6	659	2.27	35.73	1:42	1.78	20	0	0.0	0.0	0.0 - 0.0
C	7,701	27.	32.24	17:59	18.85	100	59	0.024	0.4	0.011 - 0.036
C1	584	2.02	85.93	3:25	3.58	63	0	0.0	0.0	0.0 - 0.0
C*	528	1.82	72.92	2:41	2.81	53		0.003	0.1	0.0 - 0.008
C3	1,910	6.57	64.90	9:05	9.52	67	57	0.046	2.7	0.013 - 0.079
C4	486	1.67	29.93	1:08	1.19	31	1	0.007	0.3	0.0 - 0.019
C5	1,224	4.21	12.61	1:17	1.34	16	0	0.0	0.0	0.0 - 0.0
C6	3,070	10.56	1.64	0:20	0.35	4	0	0.0	0.0	0.0 - 0.0
D	11,625	41.	40.48	36:49	38.59	162	55	0.012	0.2	0.002 - 0.021
D1A	156	0.55	53.30	0:51	0.89	29	0	0.0	0.0	0.0 - 0.0
D1B	123	0.42	74.99	1:03	1.10	24	0	0.0	0.0	0.0 - 0.0
D*A	257	0.88	74.67	1:25	1.48	37	0	0.0	0.0	0.0 - 0.0
D2B	155	0.53	117.00	1:38	1.71	37	0	0.0	0.0	0.0 - 0.0
D3	1,997	6.87	87.65	14:18	14.99	95	51	0.029	1.4	0.006 - 0.053
D4	1,018	3.50	60.28	4:18	4.51	71	0	0.0	0.0	0.0 - 0.0
D5	2,809	9.66	32.78	6:35	6.90	60	0	0.0	0.0	0.0 - 0.0
D6	5,303	18.24	16.55	6:51	7.18	47	4	0.005	0.2	0.0 - 0.014

Table B-6. Summary statistics from aerial surveys of bowhead whales conducted September-October 1979-1981 in the Beaufort Sea. Values for each region were taken from Tables B-6, B-7 and B-8, respectively (Ljungblad et al., 1982).

1979						1980				1981			
Region Name	Region Area nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²
Total	28,609	42.86	75	150	0.012	50.41	84	20	0.001	42.93	259	204	0.017
A	3,792	20.91	16	5	0.006	19.96	15	0	0.0	6.41	17	0	0.0
A1	654	8.53	11	0	0.0	25.95	15	0	0.0	13.31	10	0	0.0
A2	479	26.61	9	0	0.0	34.23	18	0	0.0	14.76	9	0	0.0
A3	789	28.37	15	1	0.004	40.20	19	0	0.0	10.78	13	0	0.0
A4	1,518	22.69	15	4	0.012	7.29	13	0	0.0	0.06	1	0	0.0
A5	384	10.70	4	0	0.0	0.00				0.00			
B	5,569	13.12	8	41	0.056	72.68	46	4	0.001	42.60	89	8	0.003
B1	739	0.69	2	0	0.0	123.32	70	0	0.0	39.26	47	0	0.0
B2	1,079	28.85	17	0	0.0	129.31	99	0	0.0	92.89	76	0	0.0
B3	793	32.31	23	41	0.160	114.31	99	4	0.004	87.10	76	8	0.012
B4	893	10.49	7	0	0.0	70.15	50	0	0.0	34.86	55	0	0.0
B5	1,463	4.45	2	0	0.0	12.59	10	0	0.0	5.26	16	0	0.0
B6	659	0.00				0.00				0.00			
c	7,701	101.23	86	83	0.011	92.57	70	9	0.001	60.99	164	21	0.004
c1	584	397.71	156	0	0.0	283.90	133	0	0.0	163.69	123	0	0.0
C2	528	216.68	202	6	0.005	231.45	176	1	0.001	216.20	140	1	0.001
C3	1,910	192.90	129	77	0.021	186.97	125	7	0.002	125.28	132	19	0.008
C4	486	45.43	34	0	0.0	53.40	37	0	0.0	40.09	41	1	0.005
C5	1,224	34.49	23	0	0.0	17.93	12	0	0.0	0.90	7	0	0.0
c6	3,070	3.97	6	0	0.0	5.48	5	0	0.0	0.00			
D	11,625	25.59	43	21	0.007	21.31	39	7	0.003	42.75	73	175	0.035
D1A	156	43.61	26	0	0.0	70.00	25	1	0.009	81.25	24	0	0.0
D1B	123	24.23	6	0	0.0	83.12	20	0	0.0	107.31	24	0	0.0
D2A	257	186.88	51	1	0.002	129.63	44	0	0.0	157.59	62	0	0.0
D2B	155	47.89	17	0	0.0	120.95	32	3	0.016	189.02	45	5	0.017
D3	1,997	68.67	76	19	0.014	71.26	62	2	0.001	146.74	104	167	0.057
D4	1,018	52.64	38	0	0.0	6.74	7	0	0.0	22.32	28	1	0.004
D5	2,809	11.30	13	1	0.003	5.55	4	0	0.0	22.42	23	0	0.0
D6	5,303	0.02	1	0	0.0	1.78	2	0	0.0	4.28	8	0	0.0

The highest bowhead density in September-October 1982 was calculated for subregion C3 (Table B-5). In 1981, 1980 and 1979 peak densities for this time frame were calculated for subregions D3, D2B, and B3, respectively (Table B-6). Subregion D2B is an area that encompasses Demarcation Bay, where bowheads are often seen feeding in September, while subregions D3, C3, and B3 correspond to the 20-m to 50-m contour, along which westerly migrating bowheads are commonly seen.

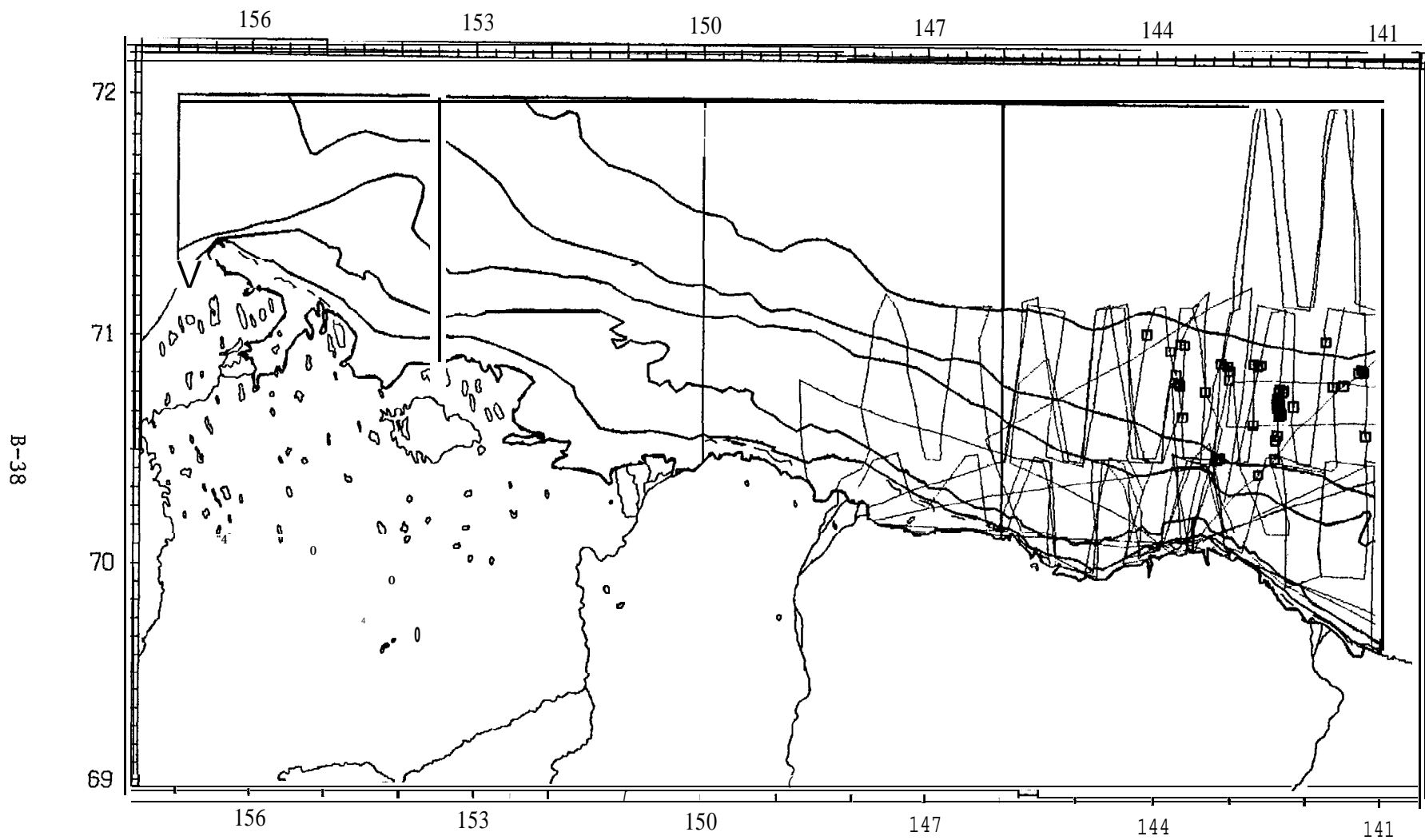


Figure B-18. Plot of aerial **survey tracklines** and bowhead whale sightings made during 1-15 August 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

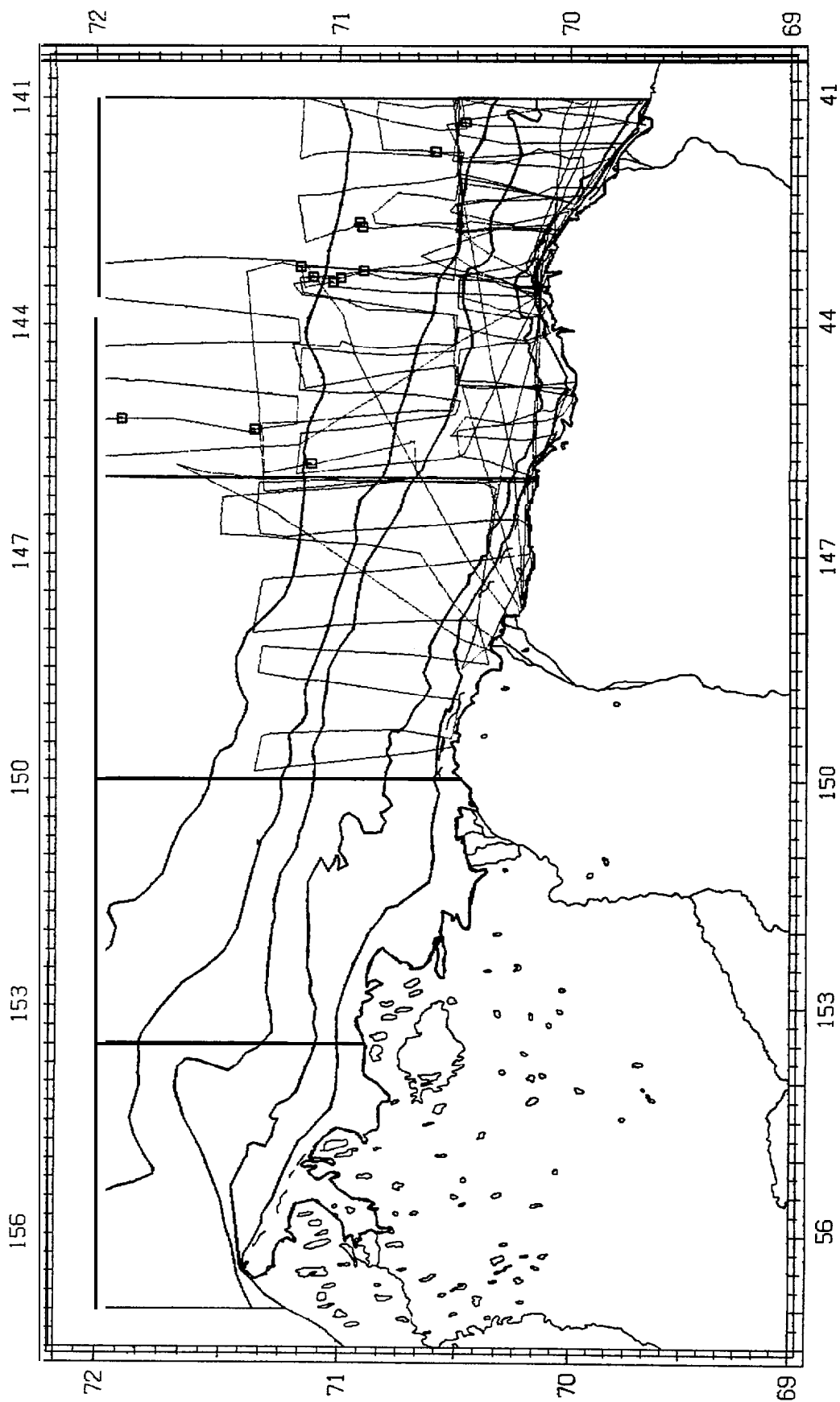


Figure B-19. Plot of aerial survey tracklines and bowhead whale sightings made during 16-31 August 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

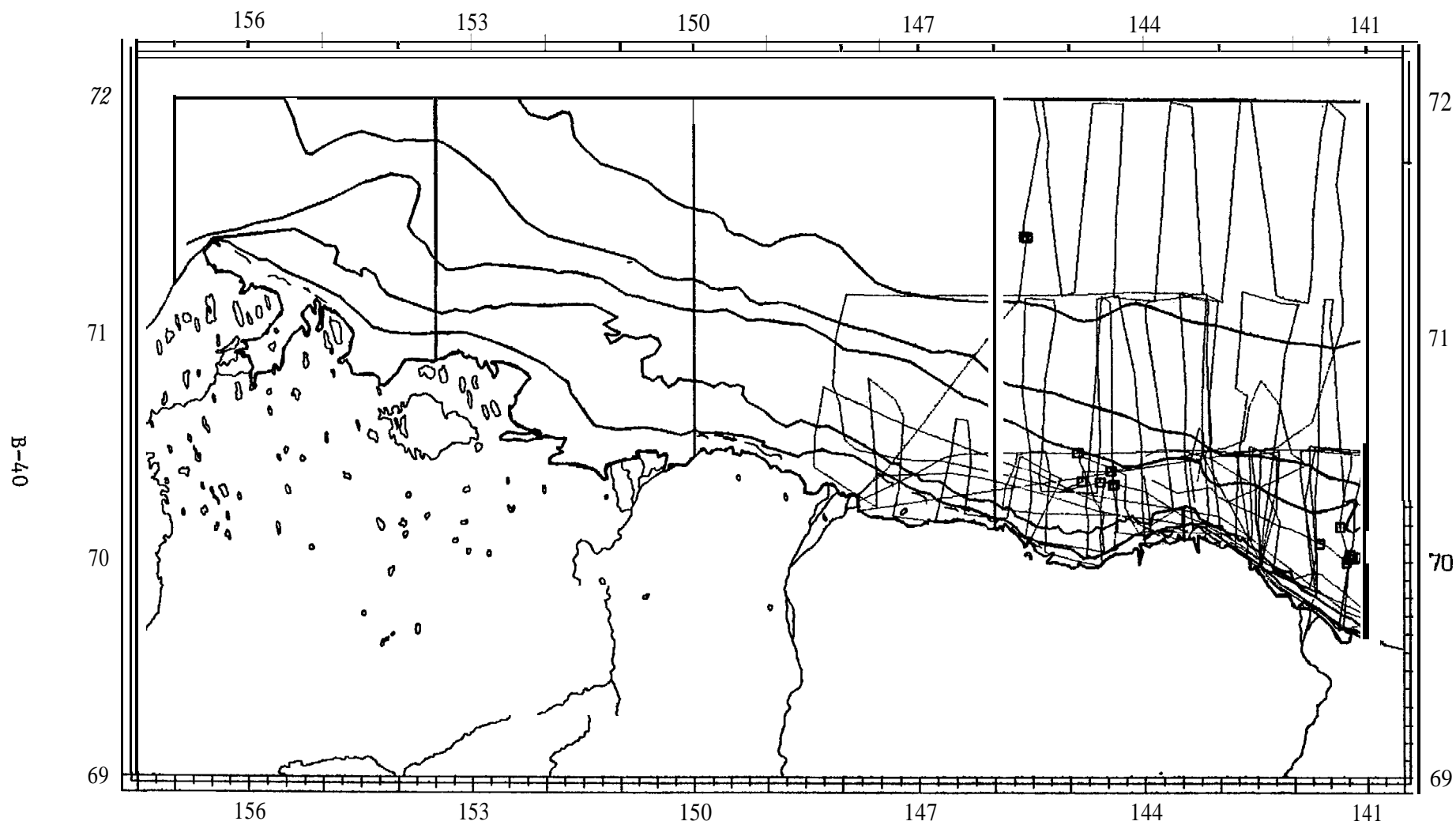


Figure B-20. Plot of aerial survey **tracklines** and bowhead whale sightings made during 1-15 September 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

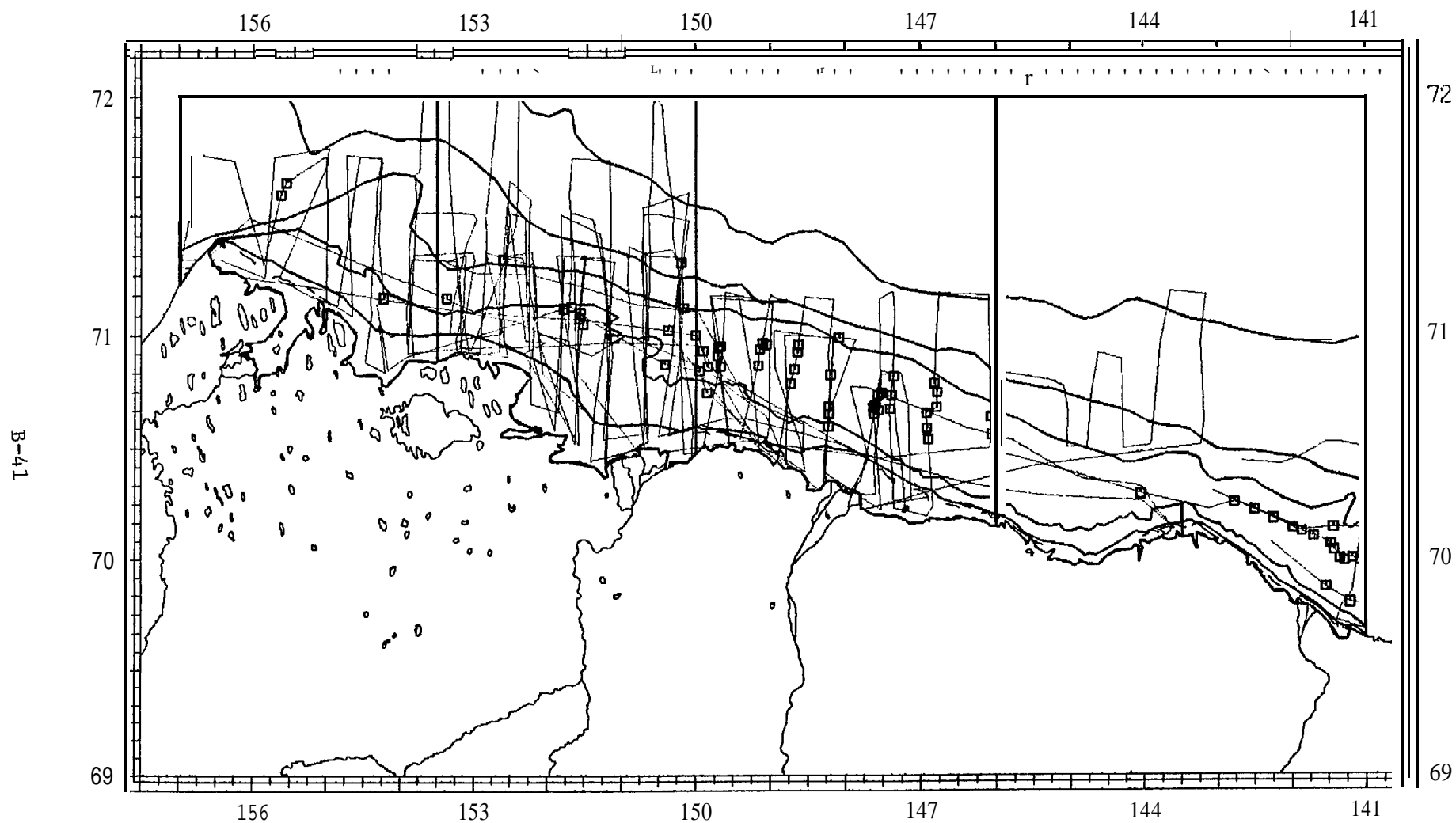


Figure B-21. Plot of aerial survey **tracklines** and bowhead whale sightings made during 16-30 September 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

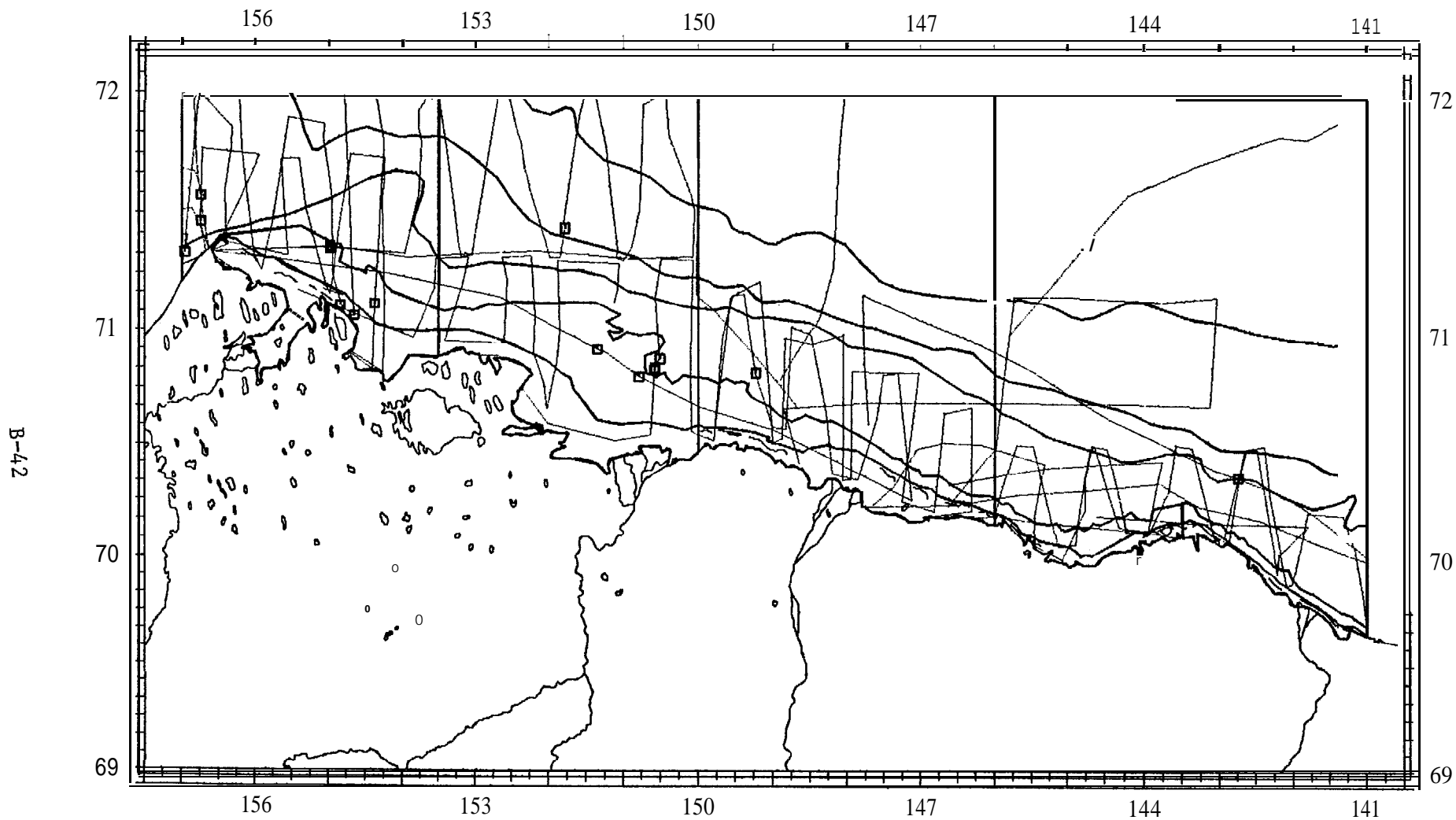


Figure B-22. Plot of aerial survey tracklines and bowhead whale sightings made during 1-15 October 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

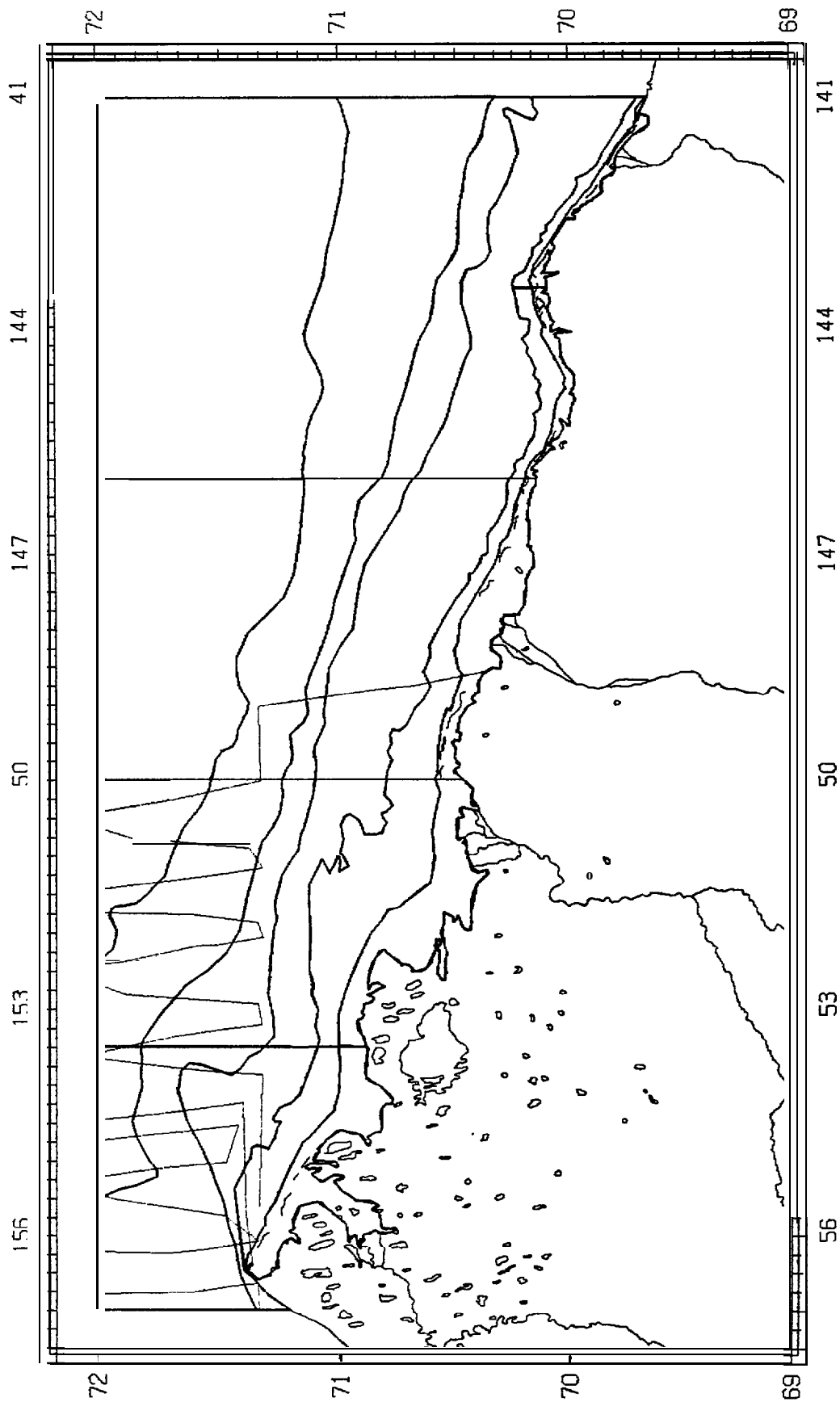


Figure B-23. Plot of aerial survey tracklines and bowhead whale sightings made during 16-31 October 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

Table B-7. Statistics from aerial survey of bowhead whales conducted August-October 1979-82 in the Beaufort Sea. Statistics apply to the total Beaufort Sea study area. The total study area was approximately 29,070 nm².

Year	Period	Percent of Area Surveyed	Survey Time HR : MIN	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nm ²	Variance	Confidence Range of Density
1979	Aug. 1-15	3.74	11:14	5	0	0.0	0.0	0.0 - 0.0
	Aug. 16-31	10.69	33:00	20	7	0.002	>0.0	>0.0 - 0.005
	Sep. 1-15	7.23	19:22	14	1	>0.0	>0.0	>0.0 - 0.001
	Sep. 16-30	11.61	31:33	22	4	0.001	>0.0	>0.0 - 0.003
	Oct. 1-15	5.29	23:02	9	77	0.051	>0.0	0.017 - 0.085
	Oct. 16-31	18.73	58:36	30	68	0.013	>0.0	>0.0 - 0.026
1980	Aug. 1-15	3.58	13:15	9	0	0.0	0.0	0.0 - 0.0
	Aug. 16-31	4.65	10:10	7	0	0.0	0.0	0.0 - 0.0
	Sep. 1-15	9.33	26:36	20	6	0.002	>0.0	>0.0 - 0.005
	Sep. 16-30	18.85	50:17	34	7	0.001	>0.0	>0.0 - 0.002
	Oct. 1-15	17.95	40:01	21	8	0.002	>0.0	>0.0 - 0.003
	Oct. 16-31	4.28	9:44	9	0	0.0	0.0	0.0 - 0.0
1981	Aug. 1-15	0.85	1:36	3	0	0.0	0.0	0.0 - 0.0
	Aug. 16-31	5.82	12:14	19	0	0.0	0.0	0.0 - 0.0
	Sep. 1-15	11.46	23:04	53	13	0.004	>0.0	>0.0 - 0.056
	Sep. 16-30	13.77	34:37	46	145	0.037	>0.0	0.018 - 0.056
	Oct. 1-15	17.70	41:37	160	46	0.009	>0.0	0.006 - 0.012
	Oct. 16-31	0.00						
1982	Aug. 1-15	12.18	31:05	154	64	0.018	0.6	0.003 - 0.034
	Aug. 16-31	14.76	36:17	158	15	0.004	0.1	0.0 - 0.009
	Sep. 1-15	12.19	25:19	114	7	0.002	>0.0	>0.0 - 0.005
	Sep. 16-30	17.11	39:46	174	113	0.023	0.3	0.012 - 0.034
	Oct. 1-15	12.72	25:56	134	25	0.007	0.1	0.002 - 0.011
	Oct. 16-31	2.19	4:24	28	0	0.0	0.0	0.0 - 0.0

Bowhead density in the Beaufort Sea peaked between 16-30 September in 1981 and 1982. In 1979 peak density was calculated for the period 1-15 October, and in 1980 no peak was discernible between 1 September and 15 October (Table B-7).

The objectives of the fall surveys have changed each year since 1979, resulting in some regions and/or subregions suffering from missing or minimal data. In 1979 nearly all effort was concentrated near the proposed State/Federal oil lease areas. Surveys were flown in June and August consistently south of 70°40'N latitude between 143°W and 149°W longitude (Ljungblad et al., 1982, Fig. B-14), with some effort in September and October between 146°W and 151°W longitude north to 71°20'N (Ljungblad et al., 1982, Fig. B-25). In 1980 there was considerable effort offshore between 71°20'N and 71°40'N latitude with some surveys extending north to 72°N in June and August (Ljungblad et al., 1982, Fig. B-18), but once again most effort was expended near the proposed lease areas between 146°W and 154°W longitude south of 71°20'N latitude (Ljungblad et al., 1982, Fig. B-29). In 1981, there was almost no effort offshore (i.e. north of the 200 m. isobath; Ljungblad et al., 1982, Fig. B-22 and B-33), though in 1982 nearly equal effort was spent offshore as nearshore in August (Fig. B-10). In September and October 1982, effort was concentrated on the nearshore subregions 1 through 4 in each region (Fig. B-14). Overall for the four years there was significant effort spent on the nearshore migration or inside the 200 m. isobath with only early season (July or August) effort directed to the outer areas and only in 1980 and 1982.

Although complete coverage of all subregions was not attempted in all years since 1979 there are trends in the density of whales in each subregion when examined by time interval. In 1982 during the first half of August the offshore subregion D5 was at its peak density (Fig. B-18). By the last half of August the adjacent subregions D4 and D6 were at their densest (Fig. B-19). The nearshore subregion D3 was not densest until mid-September (Fig. B-20 and B-21). The bowheads apparently moved into subregion D5 first, their distribution spread to the north and south throughout August, then nearshore in September.

The nearshore subregion C2 peaked in the last half of September (Fig. B-21), and subregion C3 in the last half of September (Fig. B-21) or the first half of October (Fig. B-22). Subregion B2 was densest in the first half of October (Fig. B-22) and by mid-October subregion B3 was peaking in abundance (Fig. B-22 and B-23).

A summary of 1979-1981 data presented in two week time frames is presented in Table B-8. A gross abundance estimate is derived by number of bowheads/number of transects (B/T). In 1979 bowheads were found in offshore water deeper than 50 m. in the last half of August and first half of September, though none were seen nearshore. In late September and through the first half of October 1979 whales were abundant nearshore and not offshore essentially reflecting the pattern of movements described in 1982. In 1980 and 1981, no appreciable effort was conducted offshore, though the nearshore abundance peak in the last half of September is apparent.

Table B-8. Summary statistics of aerial surveys for bowhead whales conducted August-October 1979-1982. Number of transects (T)/Number of bowheads (B) provides a gross abundance estimator bracketed by two week time frame. Region 2, 3 = water 10m to 50m deep; Region 4, 5, 6 = water over 50m deep.

	1979			1980			1981			1982		
	Region 2, 3		Region 4, 5, 6	Region 2, 3		Region 4, 5, 6	Region 2, 3		Region 4, 5, 6	Region 2, 3		Region 4, 5, 6
	T	B	B/T	T	B	B/T	T	B	B/T	T	B	B/T
1 - 15 August	2	5	0.00	0	0	0	1	8	0.00	6	0	0
16 - 31 August	5	2	0.00	26	4	0.15	2	0	0.00	4	0	0
1 - 15 September	5	0	0.00	12	2	0.17	42	2	0.05	10	0	0
16 - 30 September	68	10	0.15	20	1	0.05	78	13	0.17	16	0	0
1 - 15 October	31	44	1.42	2	0	0	88	8	0.09	8	0	0
16 - 31 October	62	31	0.50	36	2	0.06	7	0	0	0	0	0
Total	288	85	0.30	96	9	0.09	253	23	0.09	44	0	0

BERING AND CHUKCHI SEAS STUDY AREA

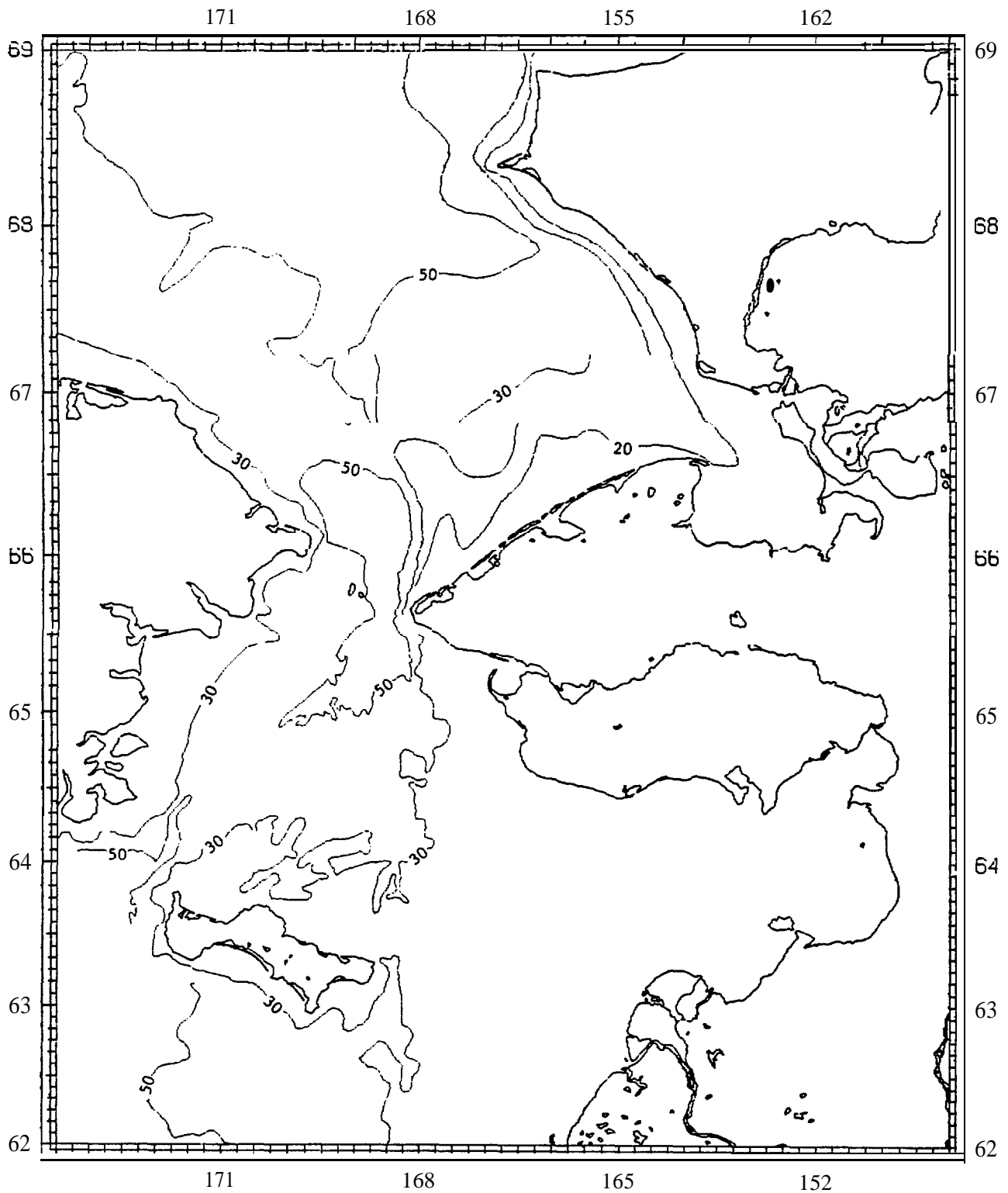


Figure B-24. Bering and Chukchi Seas depth contour lines in meters.

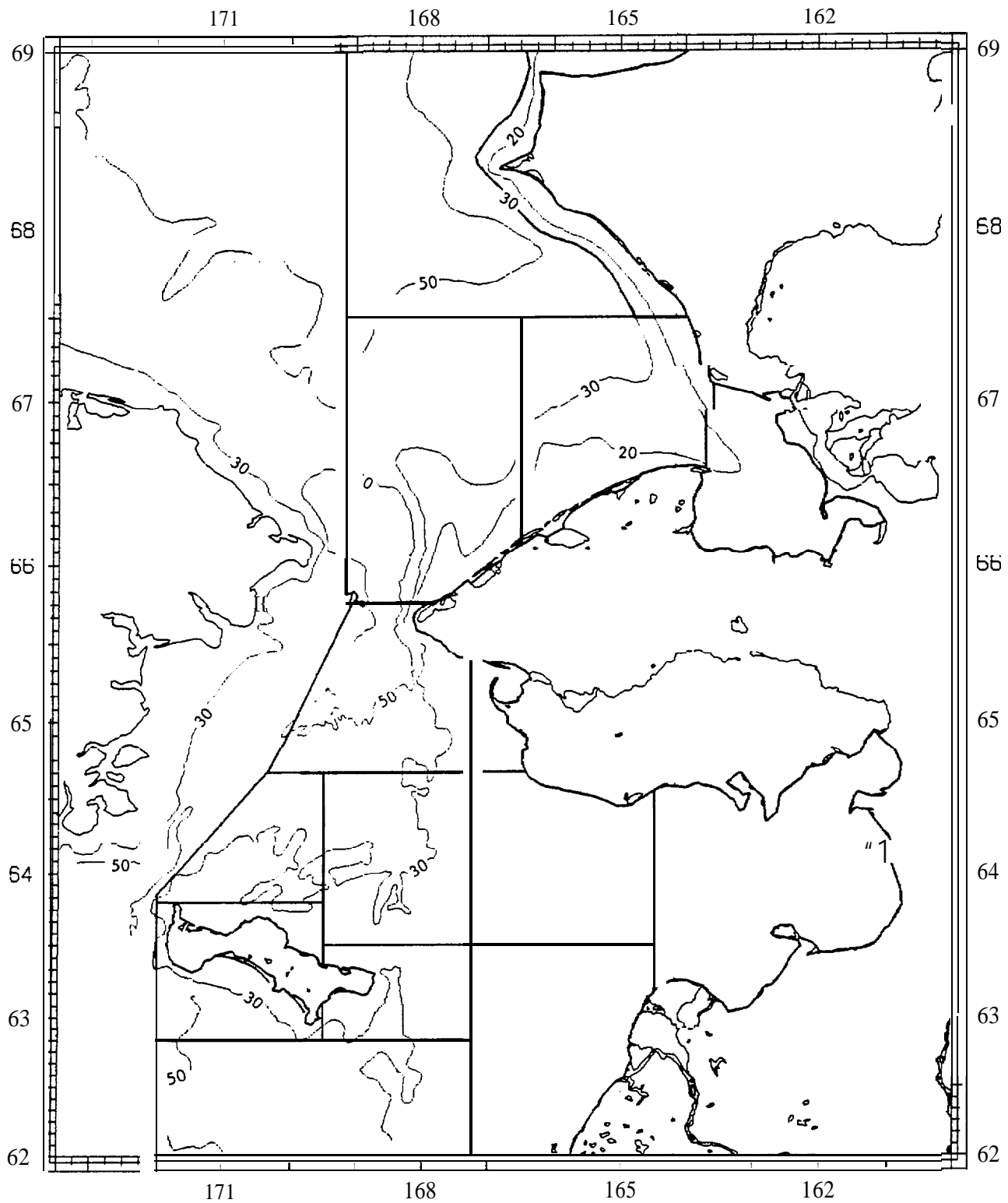


Figure B-25. Map depicting survey areas in relation to depth contours in the Bering and Chukchi Seas.

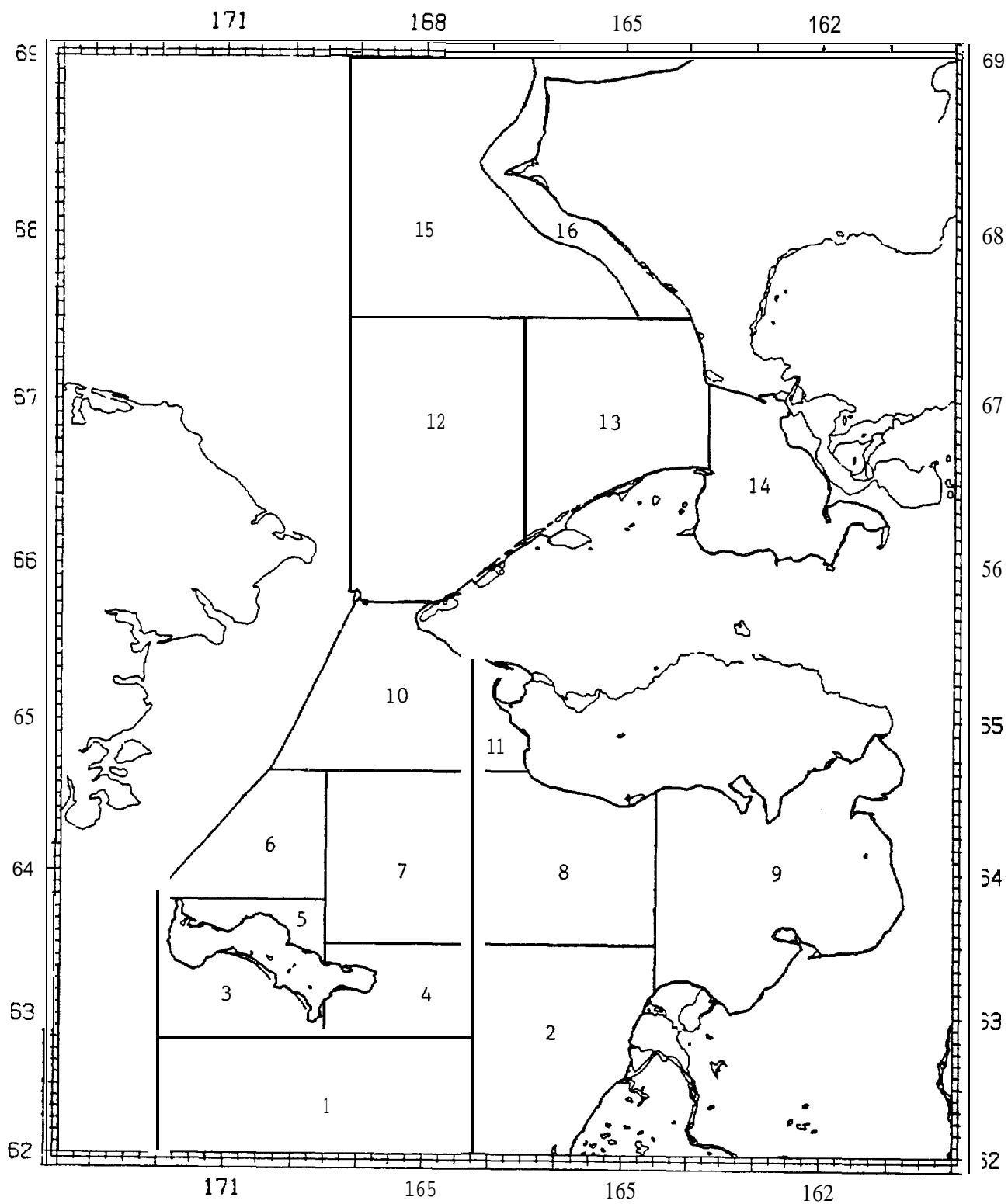


Figure B-26. The Bering and Chukchi Seas were divided into 17 regions.
 Region 17 is depicted in Figure B-27.

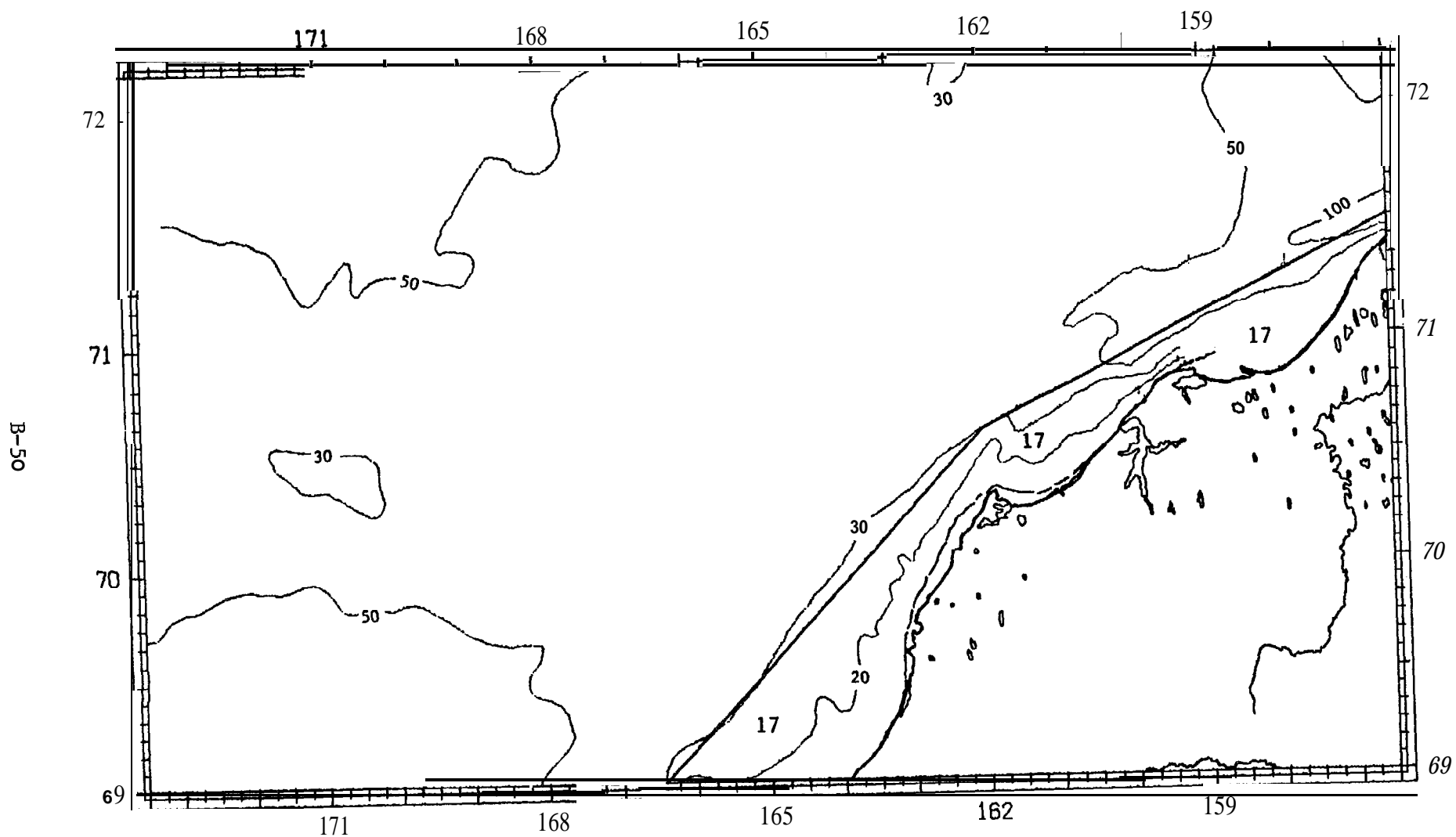


Figure B-27. Map depicting the survey area 17 in relation to depth contours in the Chukchi Sea.

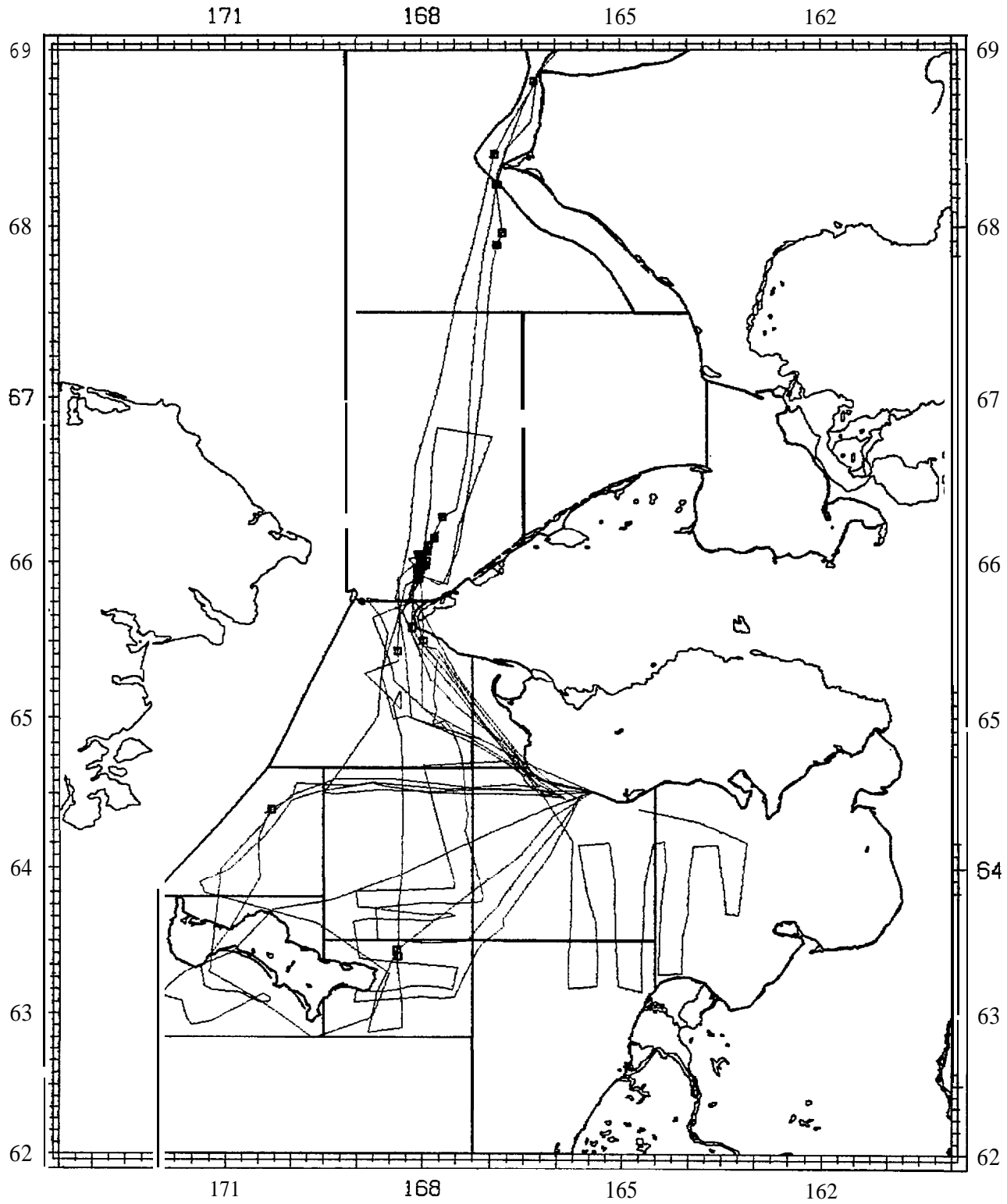


Figure B-28. Plot of aerial survey tracklines flown during April-May 1982 in the Bering and Chukchi Seas, regions 1-16. Squares represent bowhead whale sightings.

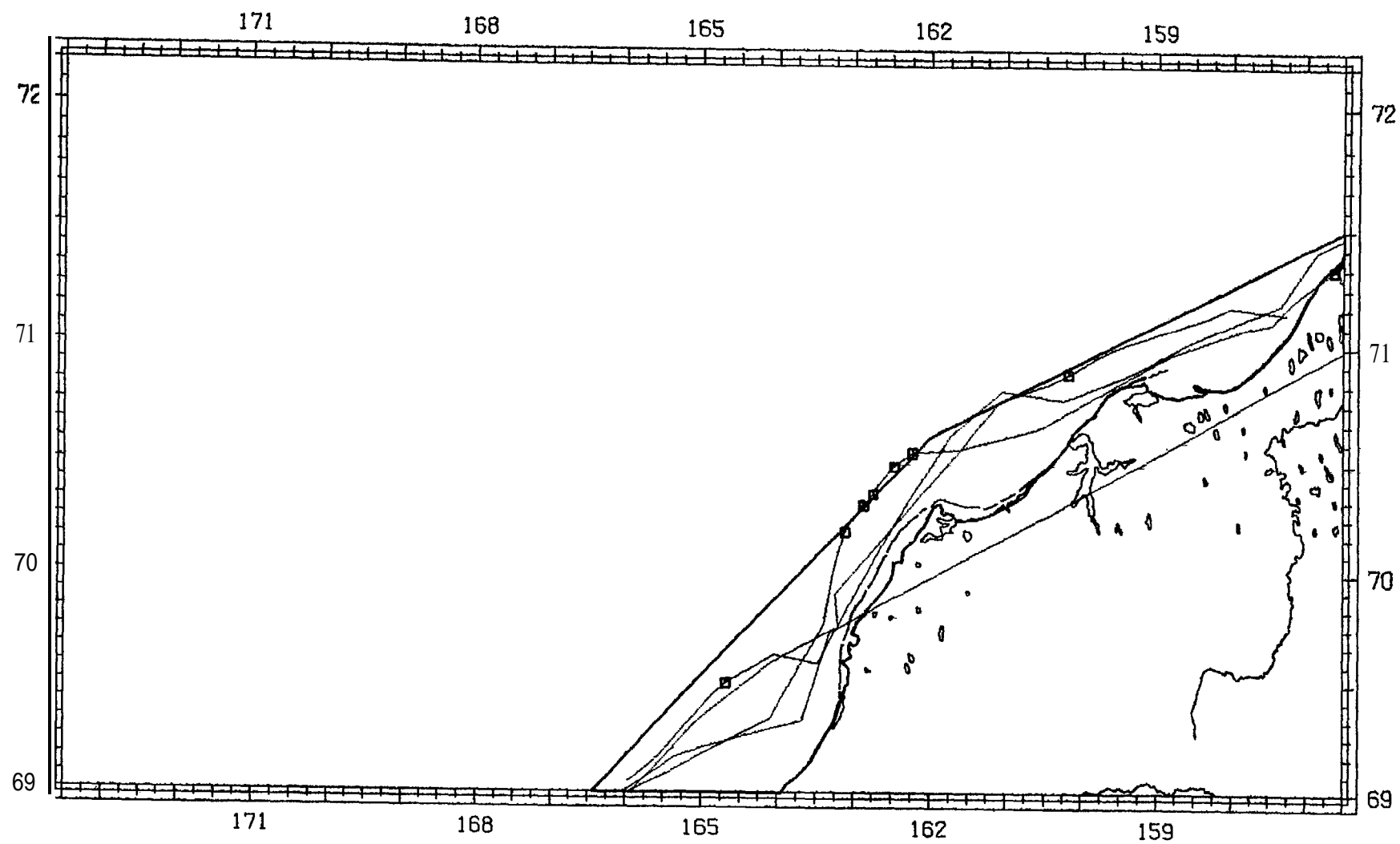


Figure B-29. Plot of aerial survey **tracklines** flown during April-May 1982 in the Chukchi Sea, region 17. Squares represent **bowhead** whale sightings.

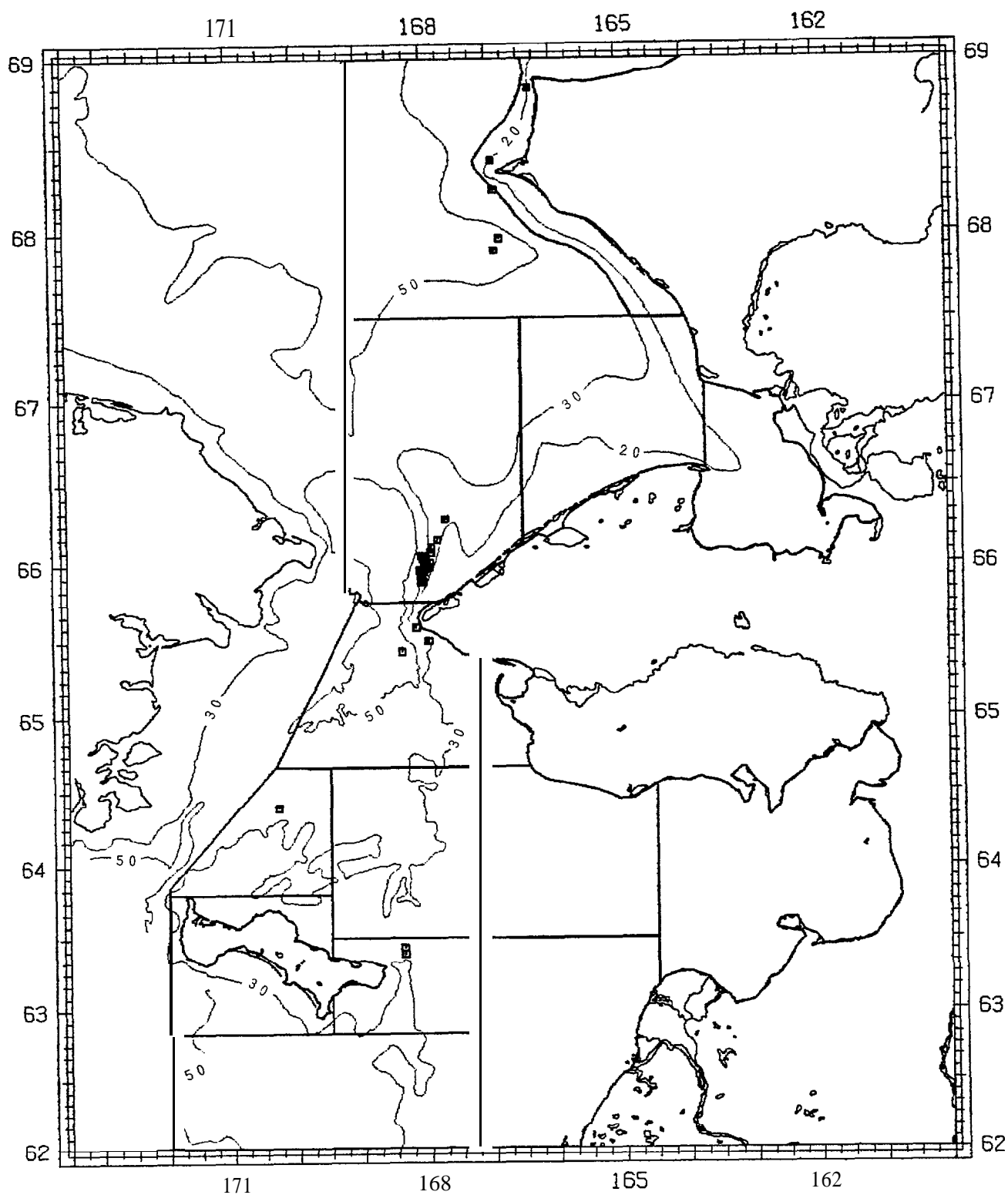


Figure B-30. Plot of bowhead whale sightings made during the April-May 1982 aerial survey of the Bering and Chukchi Seas, regions 1-16.

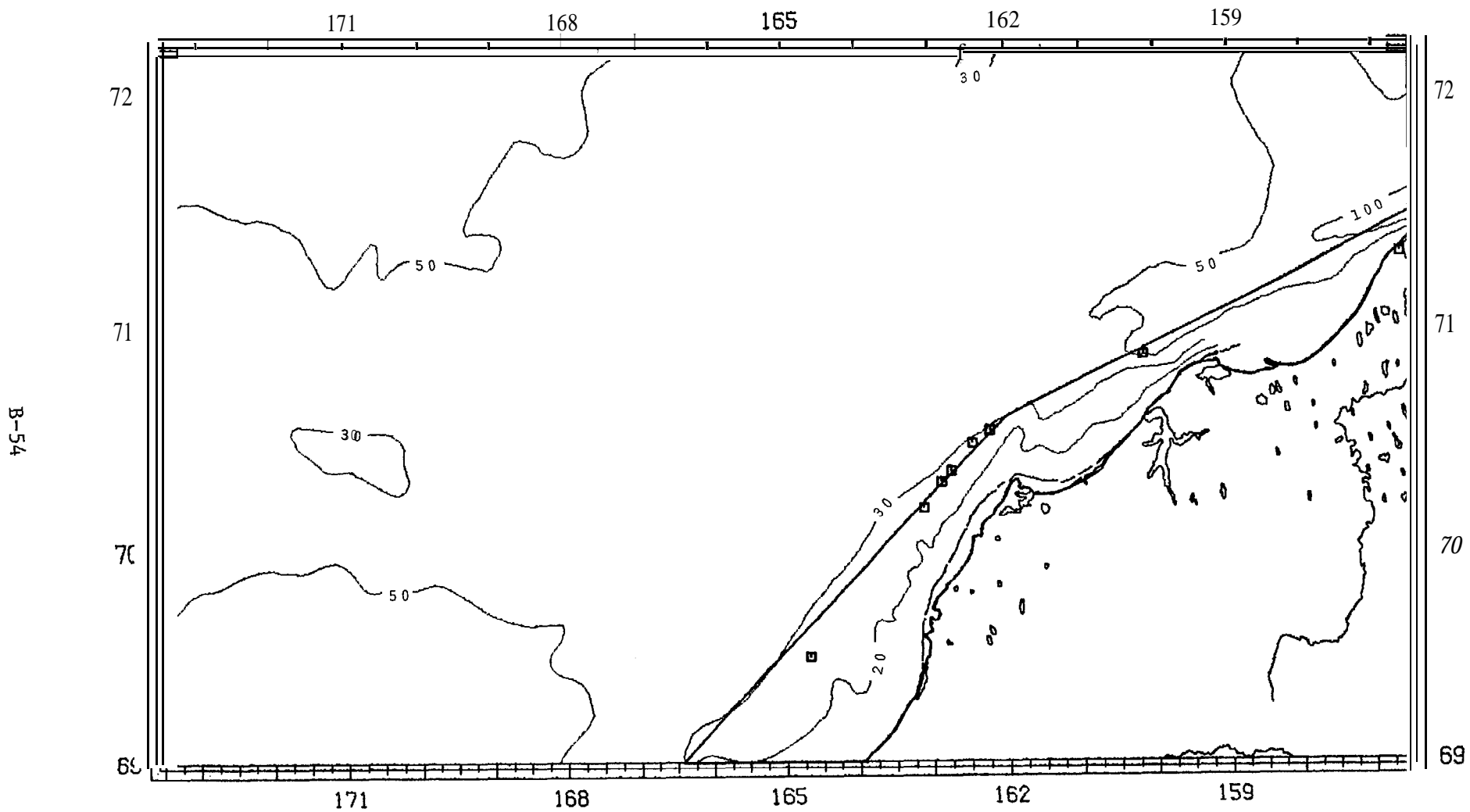


Figure B-31. Plot of bowhead whale sightings made during the April-May 1982 aerial survey of the Chukchi Sea, region 17.

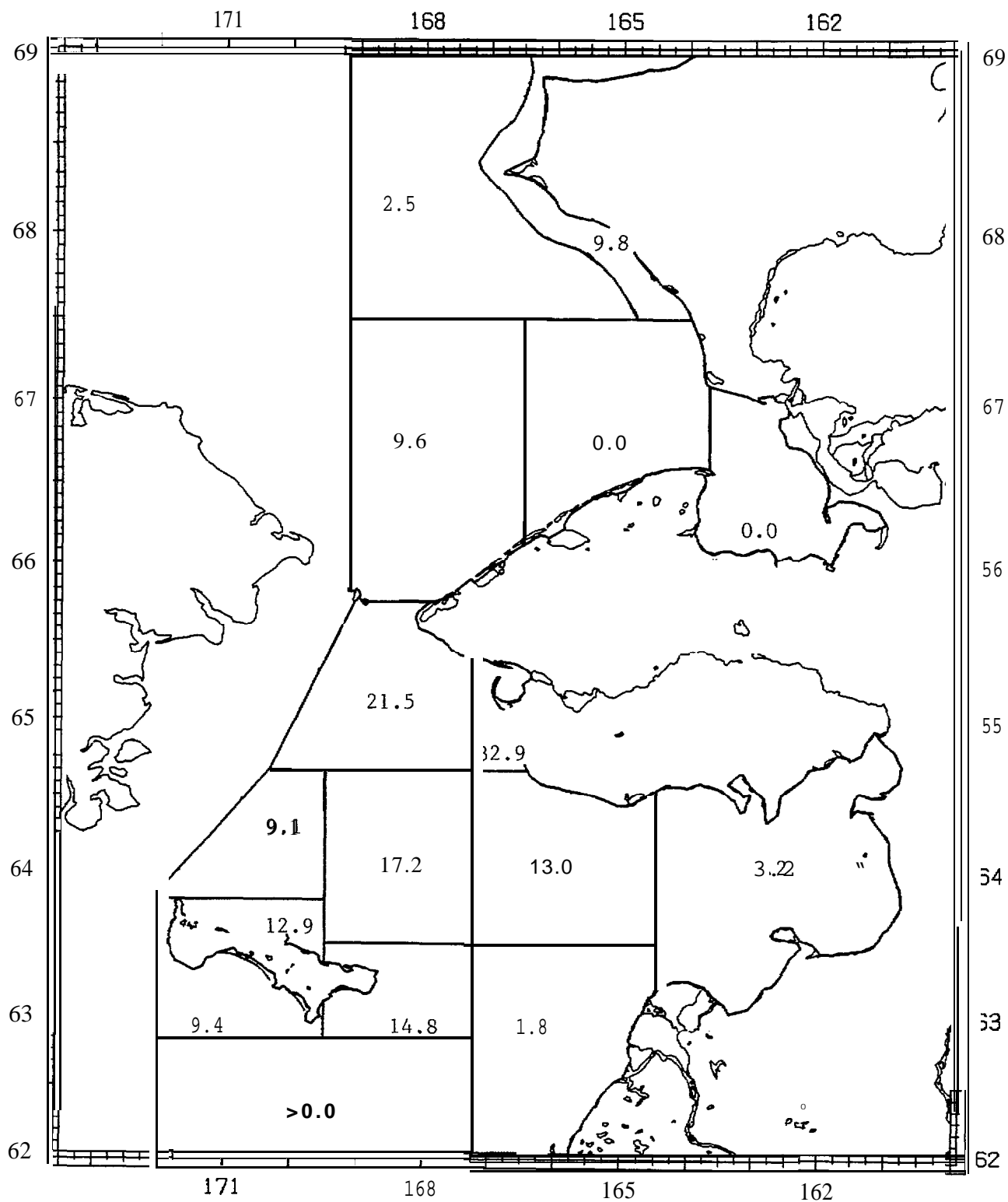


Figure B-32. Values shown are percentages expressed as total number of **survey** track miles flown divided by the area of each region. Data are based on the April-May 1982 Bering and Chukchi Seas aerial surveys. Percent coverage of Chukchi Sea region 17, not shown, was 15.5.

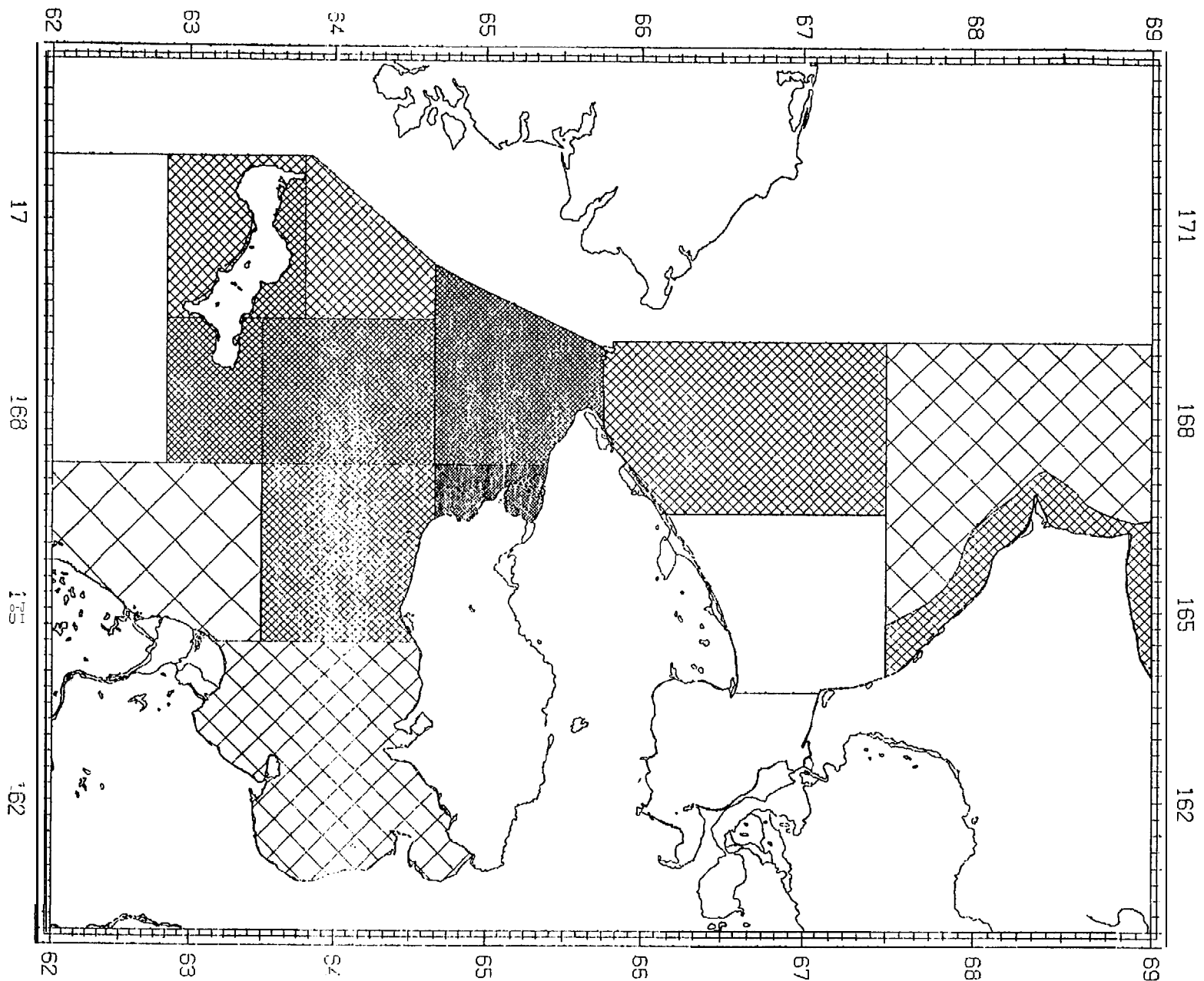


Figure B-32A. Shaded regions represent percentages expressed as total number of survey track miles flown divided by the area of each region. Shading varies from all white (representing 0 percent) to all black (representing 150 percent). Data are based on the April-May 1982 Bering and Chukchi Seas aerial surveys. Chukchi Sea region 17 is not shown.

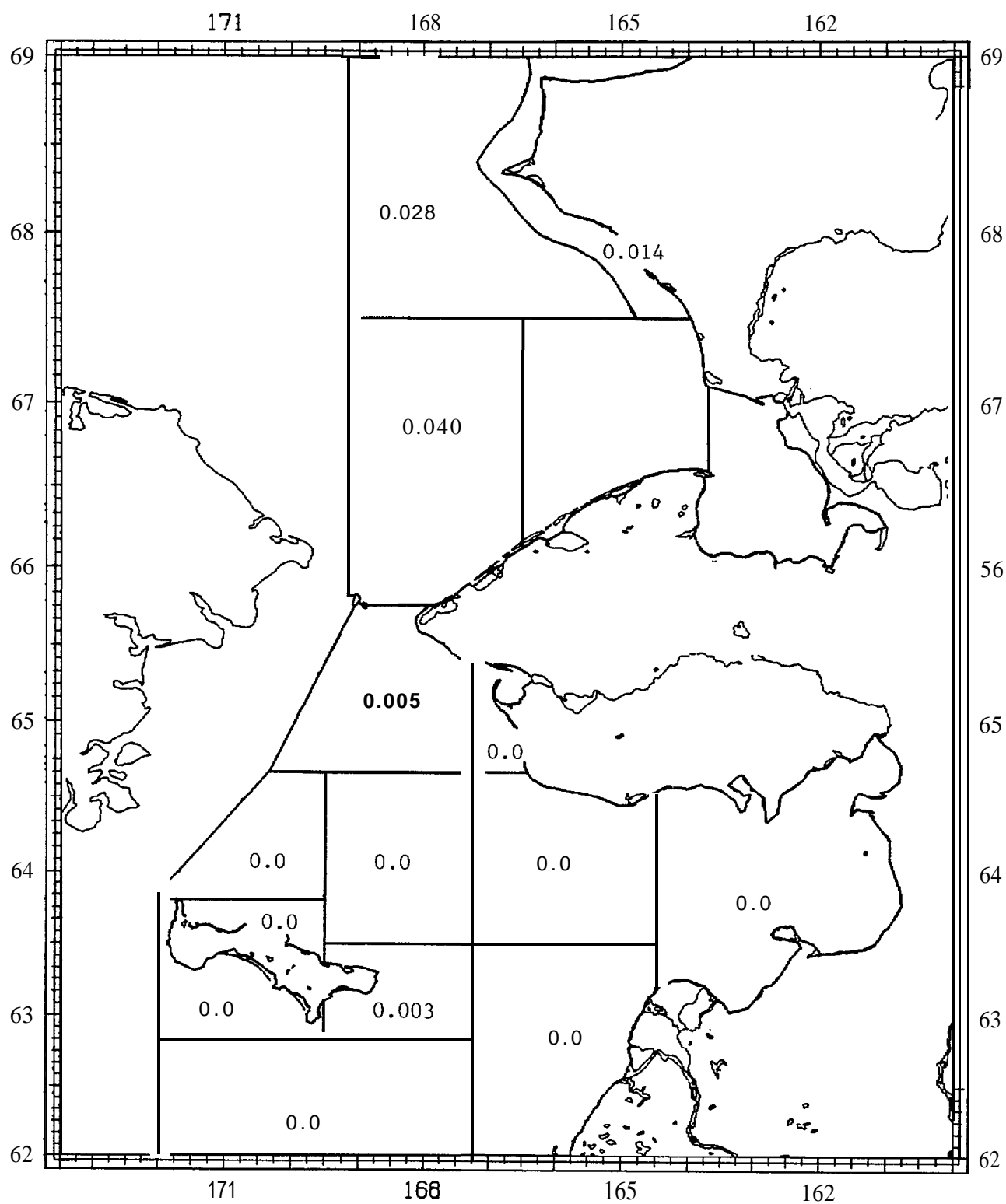
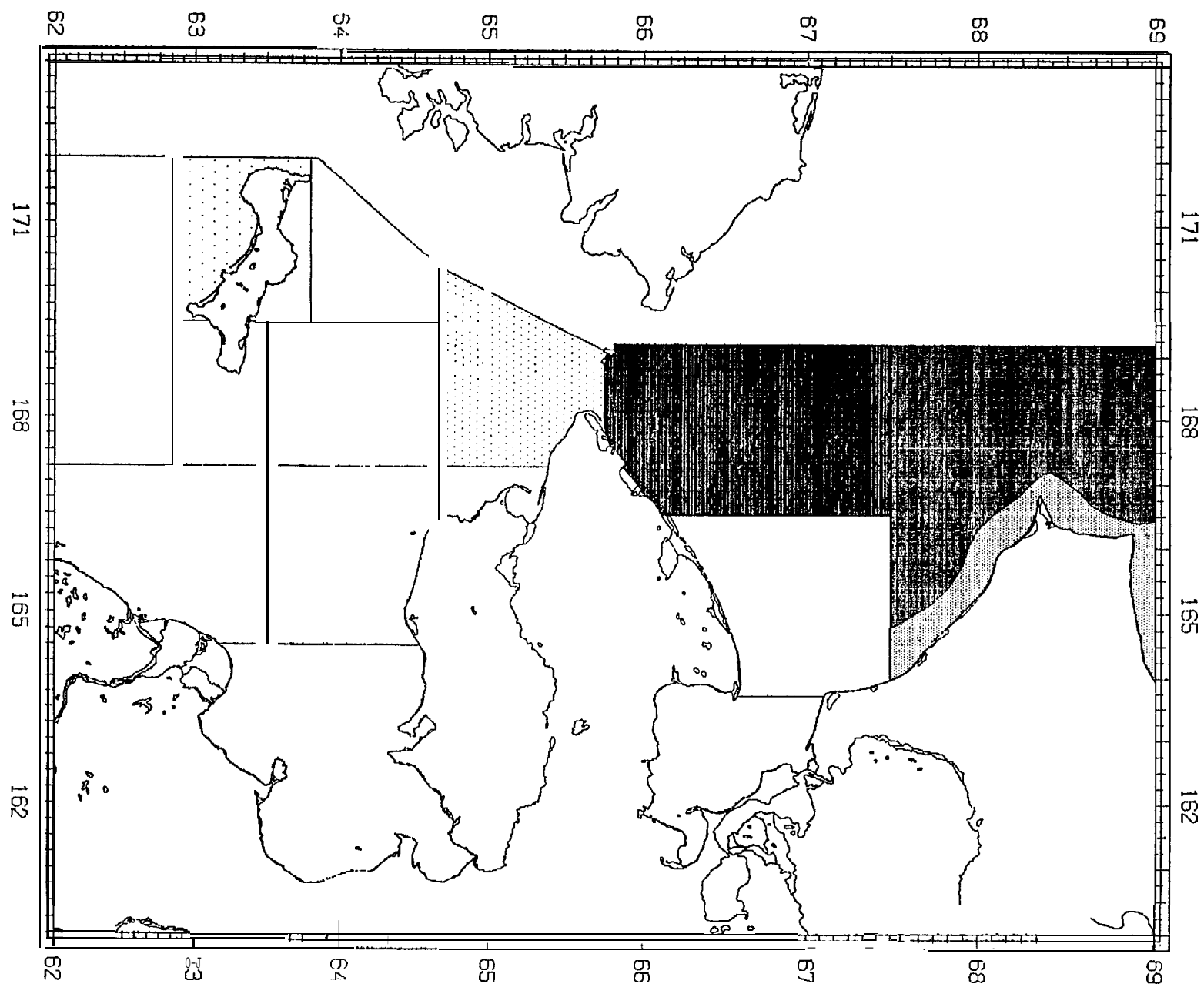


Figure B-33. Values shown are observed densities of bowhead whales as determined from aerial survey flown in the Bering and Chukchi Seas during April-May '982. Observed density in Chukchi Sea region 17, not shown, was 0.009.



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Figure B-33A. Shaded regions represent observed densities of bowhead whales as determined from aerial surveys flown in the Bering and Chukchi Seas during April-May 1982. Shading varies from all white (representing 0 density) to all black (representing 0.110 density). Chukchi Sea region 17 is not shown.

Table B-9. **Statistics from aerial survey of bowhead whales conducted April-May 1982 in the Bering and Chukchi Seas.** Values for each region are summed where appropriate. Region numbers refer to areas depicted in Figure B-26. The total study area was approximately 64,871 nmi². Total time spent surveying was approximately 38 hours and 55 minutes.

Region Name	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Percent of total Time	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Variance (*10 ⁻⁴)	Confidence Range of Density
1	6,542	10.08	0.03	0:01	0.04	1	0	0.0	0.0	0.0 - 0.0
2	5,550	8.56	1.80	0:41	1.76	6	0	0.0	0.0	0.0 - 0.0
3	2,011	3.10	9.44	1:24	3.60	5	0	0.0	0.0	0.0 - 0.0
4	2,211	3.41	14.75	2:32	6.51	10	1	0.003	>0.0	0.0 - 0.007
5	724	1.12	12.86	0:41	1.76	4	0	0.0	0.0	0.0 - 0.0
6	2,313	3.56	9.12	1:43	4.41	3	0	0.0	0.0	0.0 - 0.0
7	4,088	6.30	17.20	4:49	12.38	20	0	0.0	0.0	0.0 - 0.0
8	4,566	7.04	12.95	4:00	10.28	26	0	0.0	0.0	0.0 - 0.0
9	7,262	11.19	3.19	1:36	4.11	9	0	0.0	0.0	0.0 - 0.0
10	3,676	5.67	21.46	6:20	16.27	16	4	0.005	0.1	0.0 - 0.012
11	767	1.18	32.85	1:47	4.58	10	0	0.0	0.0	0.0 - 0.0
12	6,185	9.53	9.58	5:28	14.05	12	24	0.040	15.3	0.0 - 0.127
13	4,140	6.38	0.0							
14	2,469	3.81	0.0							
15	5,767	8.89	2.48	1:08	2.91	3	4	0.028	3.7	0.0 - 0.110
16	1,504	2.32	9.82	1:03	2.70	3	2	0.014	1.9	0.0 - 0.073
17	5,096	7.86	15.54	5:42	14.64	11	7	0.009	1.8	0.0 - 0.039

Table B-10. Summary statistics from aerial survey of bowhead whales conducted April-May 1980 and 1981. Values for each region were taken from Tables B-10 and B-n (Ljungblad et al., 1982).

Region Name	Region Area nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²
1	6,542	0.16	1	0	0.0	0.26	2	0	0.0
2	5,550	2.68	4	0	0.0	9.18	15	0	0.0
3	2,011	2.97	3	0	0.0	11.83	8	0	0.0
4	2,211	3.12	1	0	0.0	25.45	19	0	0.0
5	724	1.64	1	0	0.0	20.68	4	0	0.0
6	2,313	2.73	1	0	0.0	49.56	14	828	0.722
7	4,088	3.27	3	4	0.030	38.68	40	0	0.0
8	4,566	14.78	15	2	0.003	42.19	55	0	0.0
9	7,262	4.31	3	0	0.0	12.28	20	0	0.0
10	3,676	20.24	23	11	0.015	25.77	25	2	0.002
11	767	35.84	13	2	0.007	39.38	13	0	0.0
12	6,185	7.57	11	312	0.666	17.33	10	28	0.026
13	4,140	3.74	3	0	0.0	0.10	1	0	0.0
14	2,469	0.00				0.00			
15	5,767	0.35	1	0	0.0	2.22	4	0	0.0
16	1,504	12.78	5	0	0.0	5.31	4	5	0.063
17	5,096	16.01	16	49	0.060	10.18	6	18	0.035

Few bowheads were seen in the northern Bering and **Chukchi** Seas in 1982 compared to 1981 and 1980. Peak density for the April-May 1982 survey period was calculated for region 12 (Table B-9). Region 12 was the area of highest density in 1980 as well, while the highest density of bowheads in 1981 was calculated for region 6, just north of St. Lawrence Island (Table B-10). Water depth in regions 6 and 12 is generally 30 m. to 50 m. The occurrence of high densities of whales in these areas in April and May may reflect annual coalescing areas for northerly bowhead migrants, or may simply reflect suitable ice coverage habitat in these regions for those years. Notably, though whales have been seen each year in the nearshore lead between Pt. Hope and Pt. Barrow, encompassed in region 17, density calculations for region 17 are far below those calculated for regions 6 and 12.

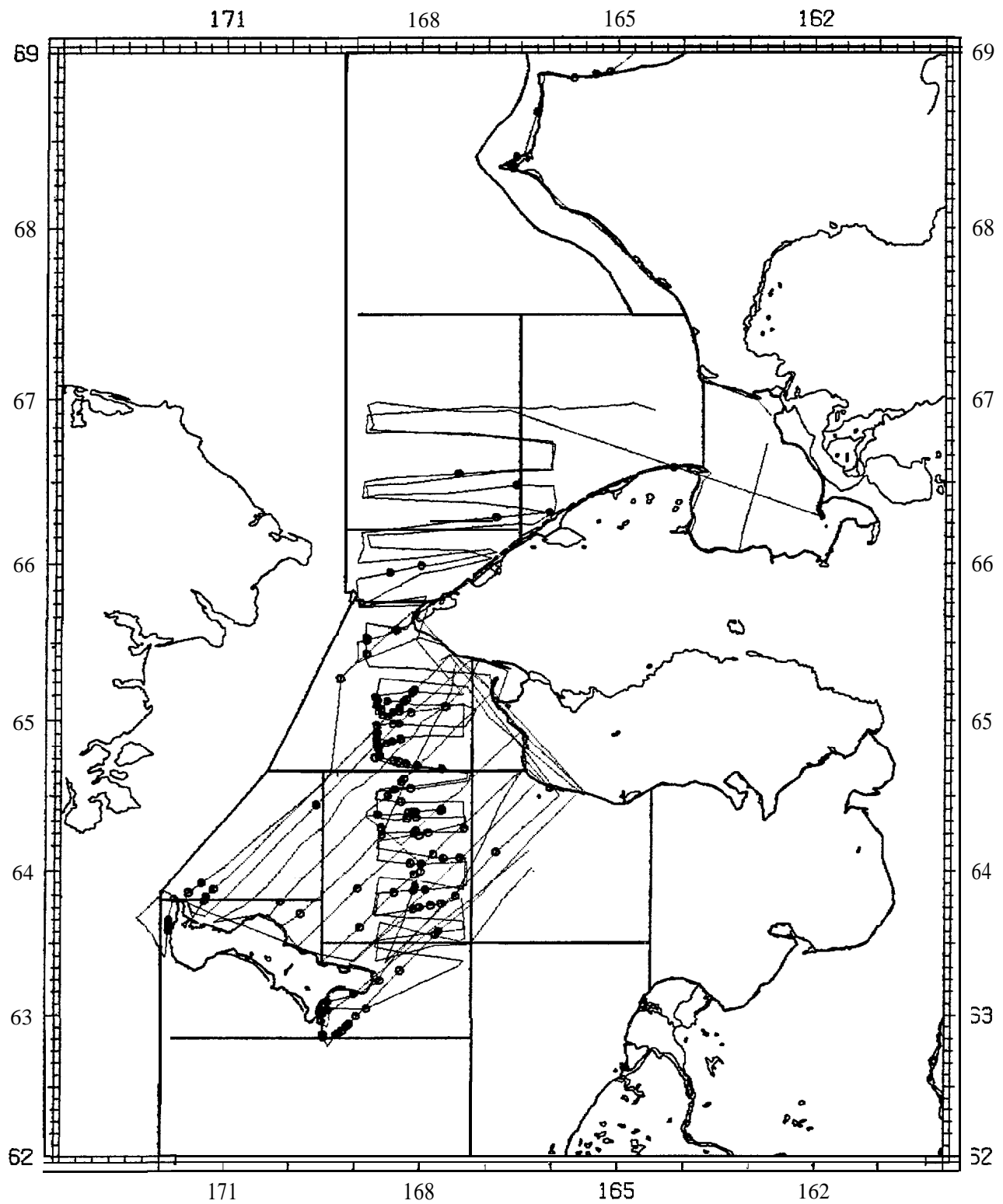


Figure B-34. Plot of aerial survey tracklines flown during July 1982 in the Bering and Chukchi Seas, regions 1-16. Circles represent gray whale sightings.

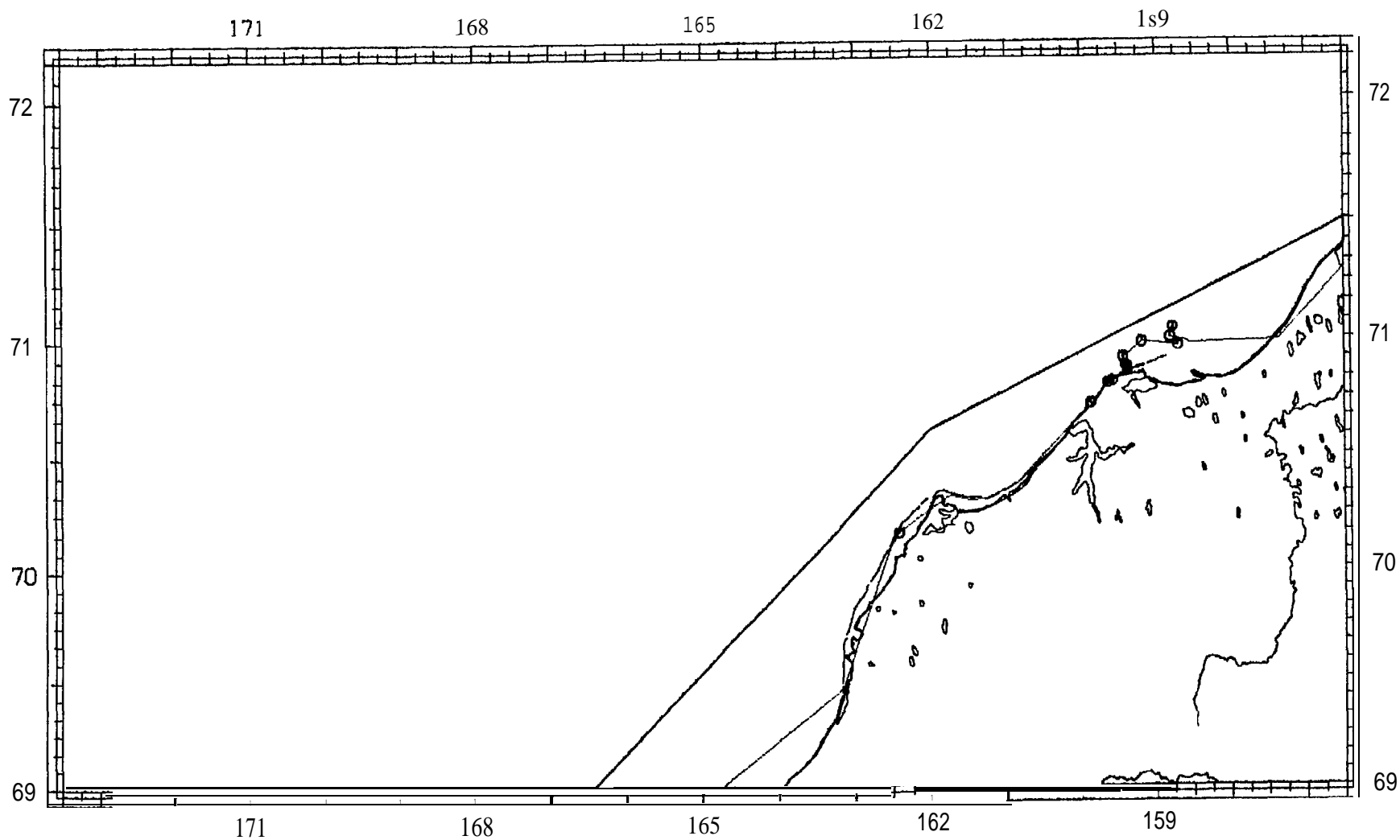


Figure B-35. Plot of aerial survey **tracklines** flown during July 1982 in the Chukchi Sea, region 17. **Circles** represent gray whale sightings.

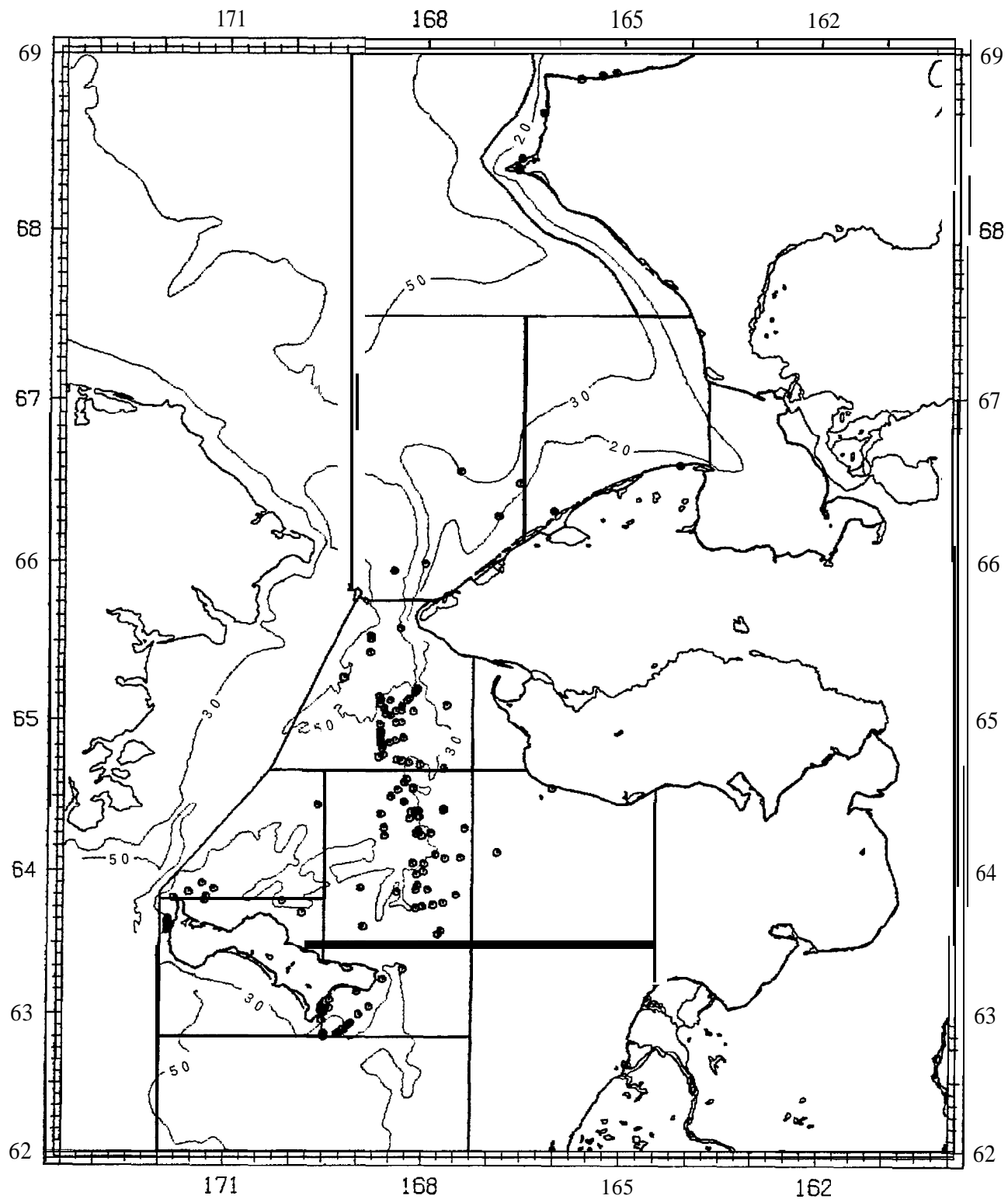


Figure B-36. Plot of gray whale sightings made during the July 1982 aerial survey of the Bering and Chukchi Seas, regions 1-16.

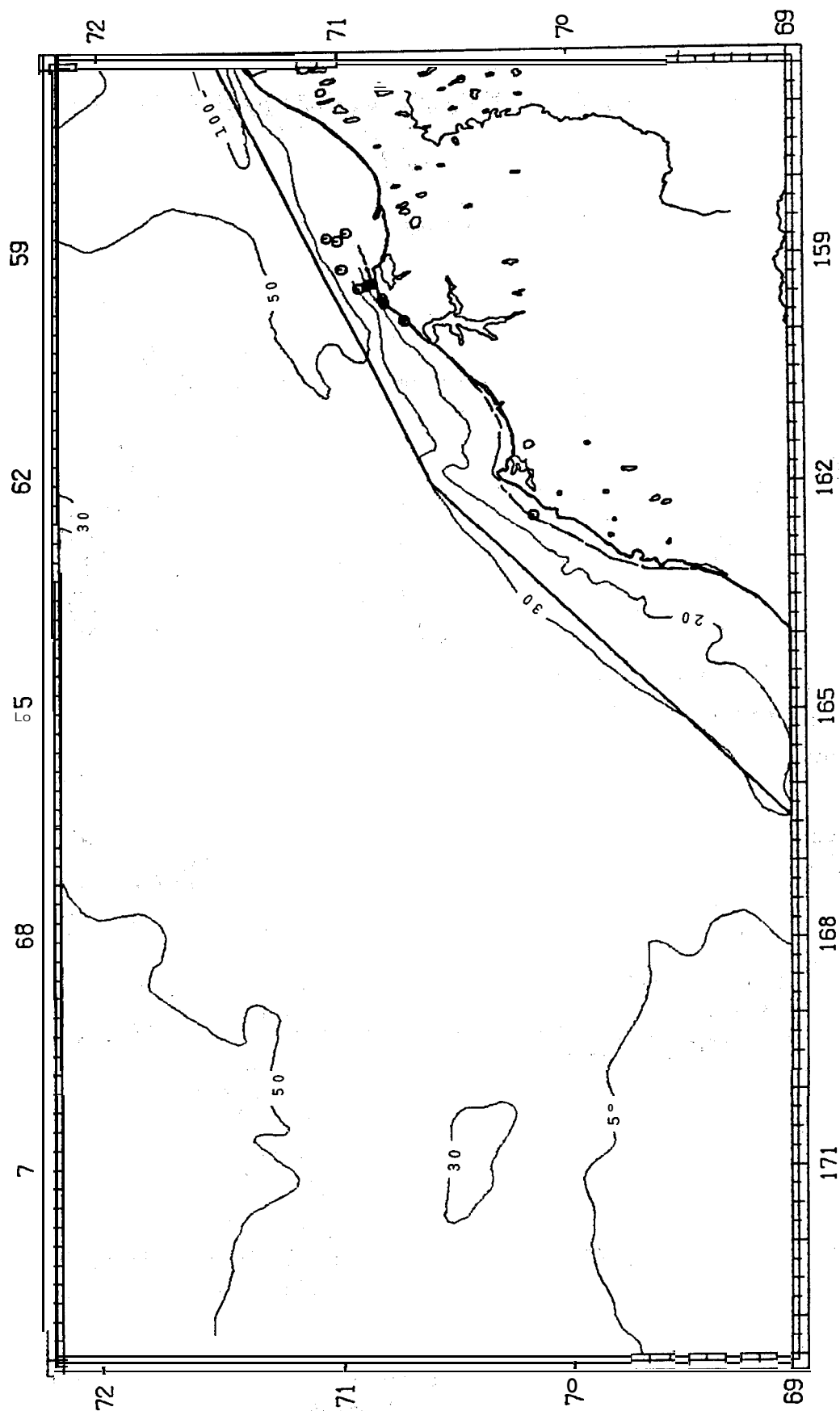


Figure B-37. Plot of gray whale sightings made during the July aerial survey of the Chukchi Sea, region 17.

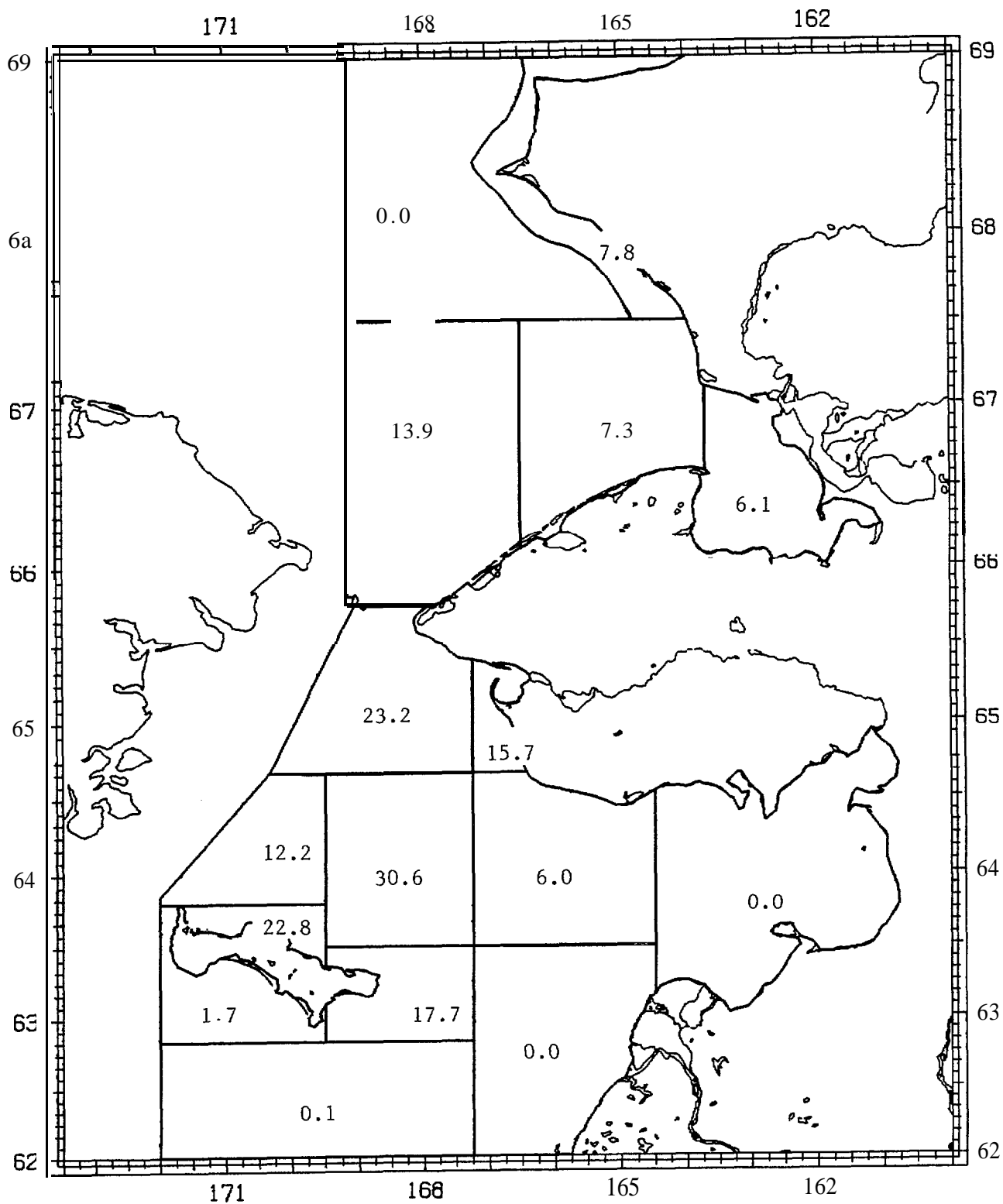


Figure B-38. Values shown are percentages expressed as total number of survey track miles flown divided by the area of each region. Data are based on the July 1982 Bering and Chukchi Seas aerial surveys. Percent coverage of Chukchi Sea region 17, not shown, was 3.8.

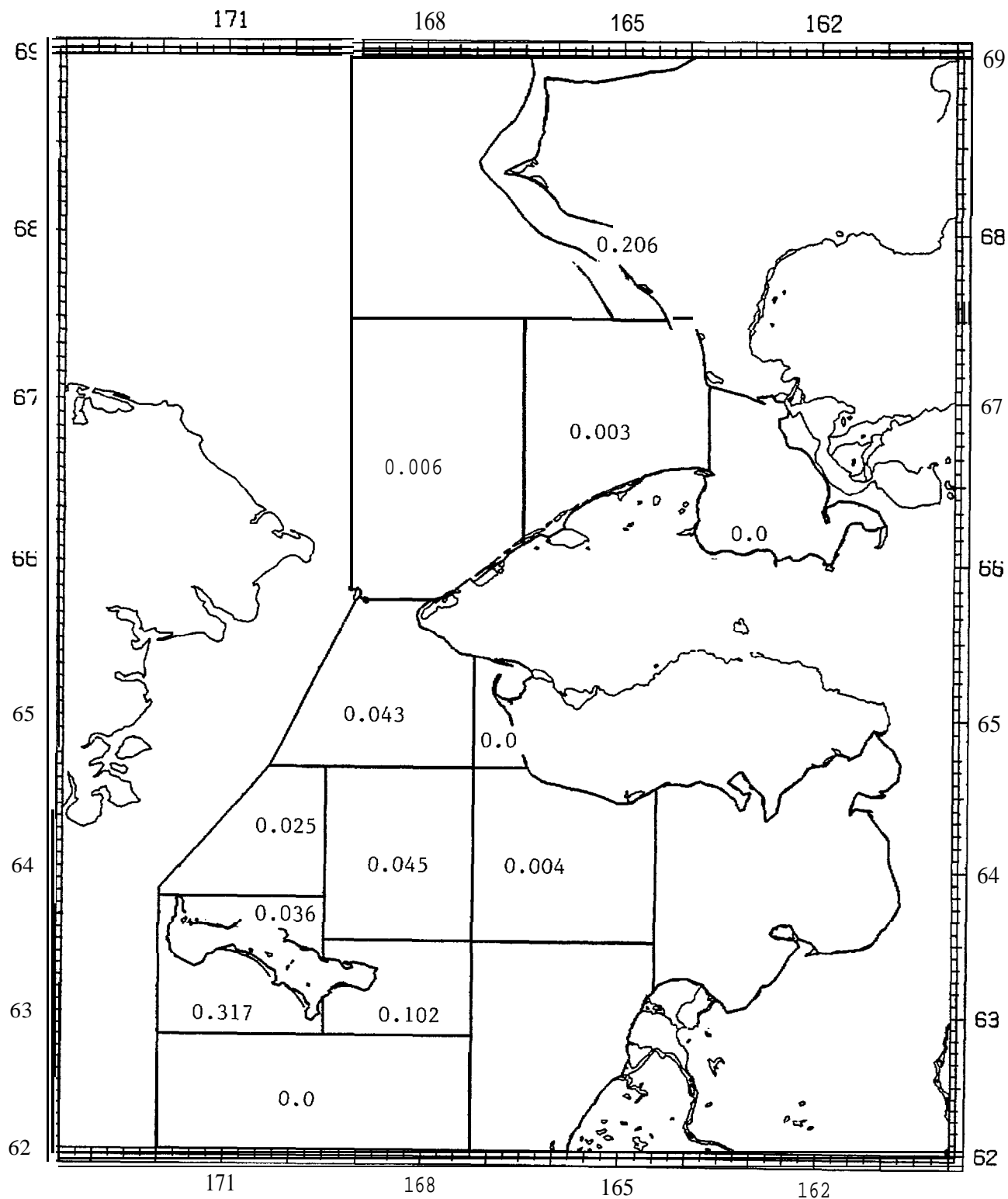


Figure B-39. Values shown are observed densities of gray whales as determined from aerial survey flown in the Bering and Chukchi Seas during July 1982. Observed density in Chukchi Sea region 17, not shown, was 0.430.

Table B-11. Statistics from aerial survey of gray whales conducted July 1982 in the Bering and Chukchi Seas. Values for each region are summed where appropriate. Region numbers refer to areas depicted in Figure B-26. The total study area was approximately 64,871 nmi². Total time spent surveying was approximately 40 hours and 23 minutes.

Region Name	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Percent of total Time	Number of Transects Flown (=n)	Number of Grays Observed	Density as Number per nmi ²	Variance (*10 ⁻⁴)	Confidence Range of Density	
1	6,542	10.08	0.11	0:04	0.17	1	0	0.0	0.0	0.0	- 0.0
2	5,550	8.56	0.0								
3	2,011	3.10	1.73	0:14	0.58	2	11	0.317	265.9	0.0	- 2.389
4	2,211	3.41	17.66	3:21	8.30	18	40	0.102	15.5	0.019	- 0.186
5	724	1.12	22.81	1:31	3.76	8	6	0.036	8.0	0.0	- 0.103
6	2,313	3.56	12.18	2:09	5.32	8	7	0.025	1.6	0.0	- 0.055
7	4,088	6.30	30.55	9:55	24.56	48	56	0.045	0.9	0.026	- 0.064
8	4,566	7.04	6.02	2:14	5.53	9	1	0.004	0.1	0.0	- 0.010
9	7,262	11.19	0.0								
10	3,676	5.67	23.18	6:53	17.04	37	37	0.043	2.2	0.013	- 0.074
11	767	1.18	15.73	1:06	2.72	11	0	0.0	0.0	0.0	- 0.0
12	6,185	9.53	13.85	6:25	15.89	28	5	0.006	0.1	0.0	- 0.011
13	4,140	6.38	7.30	2:12	5.45	18	1	0.003	0.1	0.0	- 0.011
14	2,469	3.81	6.05	1:06	2.72	7	0	0.0	0.0	0.0	- 0.0
15	5,767	8.89	0.0								
16	1,504	2.32	7.75	1:05	2.68	6	24	0.206	281.5	0.0	- 0.637
17	5,096	7.86	3.83	2:08	5.28	5	84	0.430	876.5	0.0	- 1.252

Table B-12. Statistics from aerial survey of gray whales conducted June-August 1980 and 1981 in the Bering and Chukchi Seas. Values for each region were taken from Tables B-12 and B-13 (Ljungblad et al., 1982).

Region Name	Region Area nmi ²	1980				1981			
		Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Grays Observed	Density as Number per nmi ²	Percent of Area Surveyed	Number of Transects Flown (=n)	Number of Grays Observed	Density as Number per nmi ²
1	6,542	0.00				14.68	29	1	0.001
2	5,550	0.00				11.66	25	0	0.0
3	2,011	0.00				9.32	9	1	0.005
4	2,211	0.00				25.27	21	11	0.020
5	724	0.00				0.00	0	0	0.0
6	2,313	0.00				2.56	6	0	0.0
7	4,088	0.00				25.50	41	81	0.078
8	4,566	0.22	2	0	0.0	36.33	63	0	0.0
9	7,262	1.39	1	0	0.0	20.77	51	0	0.0
10	3,676	1.23	2	0	0.0	36.87	70	155	0.114
11	767	3.69	1	0	0.0	82.07	55	5	0.008
12	6,185	1.52	1	0	0.0	18.20	35	16	0.014
13	4,140	0.48	1	0	0.0	28.98	41	0	0.0
14	2,469	0.00				28.42	32	0	0.0
15	5,767	0.50	1	0	0.0	11.94	19	14	0.020
16	1,504	3.52	3	4	0.076	65.54	47	28	0.028
17	5,096	3.86	3	4	0.020	18.58	36	41	0.043,

Peak gray whale density in July 1982 was calculated for region 17 (Table B-11). Regions 3, 4, and 16 also showed high density. In 1980 region 16 had the highest density, while in 1981 gray whale density was greatest in region 10 for the period June-August (Table B-12). Notably no surveys were conducted in regions 1-7 in 1980. We have not ascertained the effect of survey time frame on calculated gray whale densities.

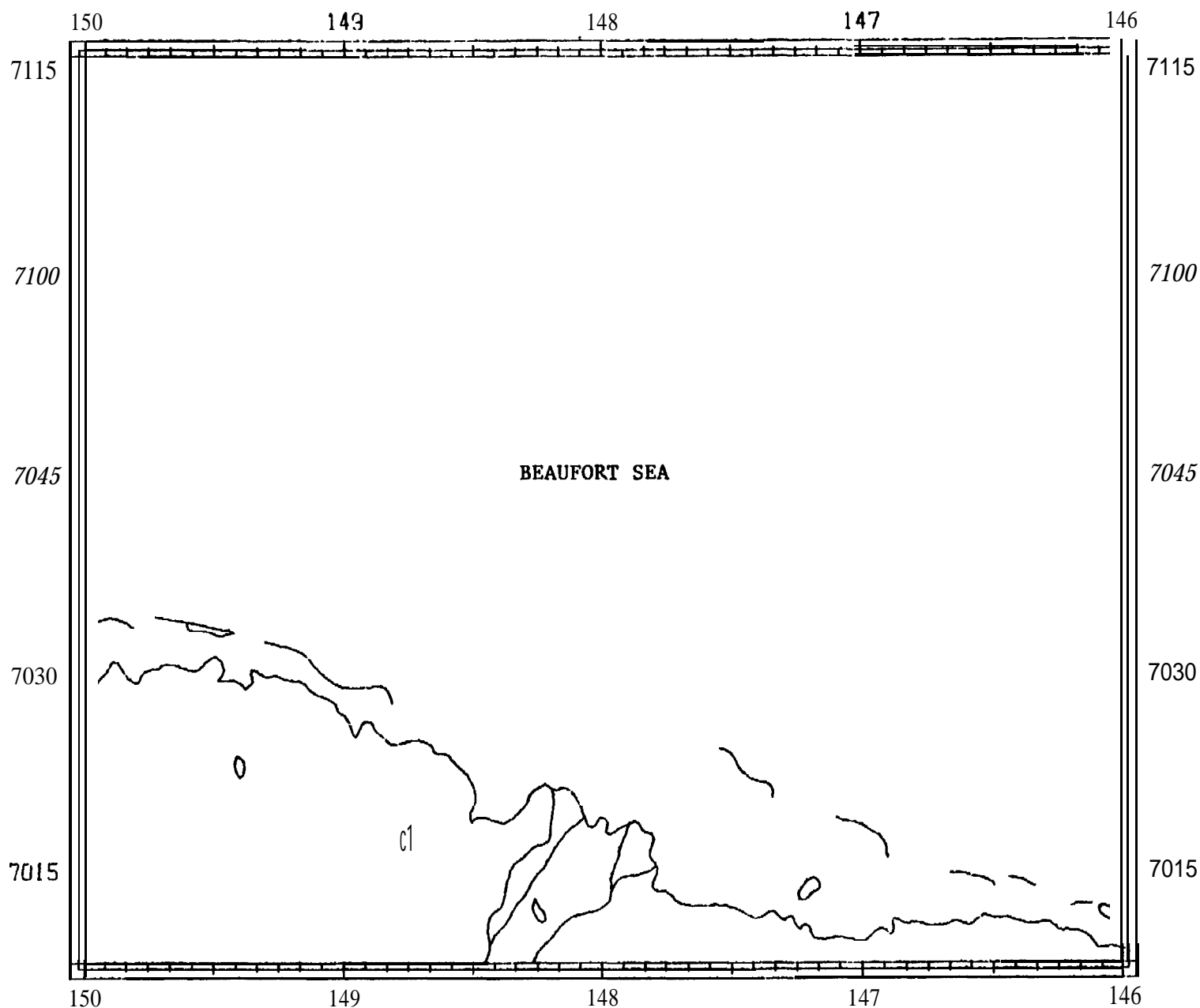


Figure B-40. The total Beaufort Sea study area was bounded on the east by 146 00' W longitude, on the west by 150 00' W longitude, on the south by the coast and on the north by 71 16' N latitude.

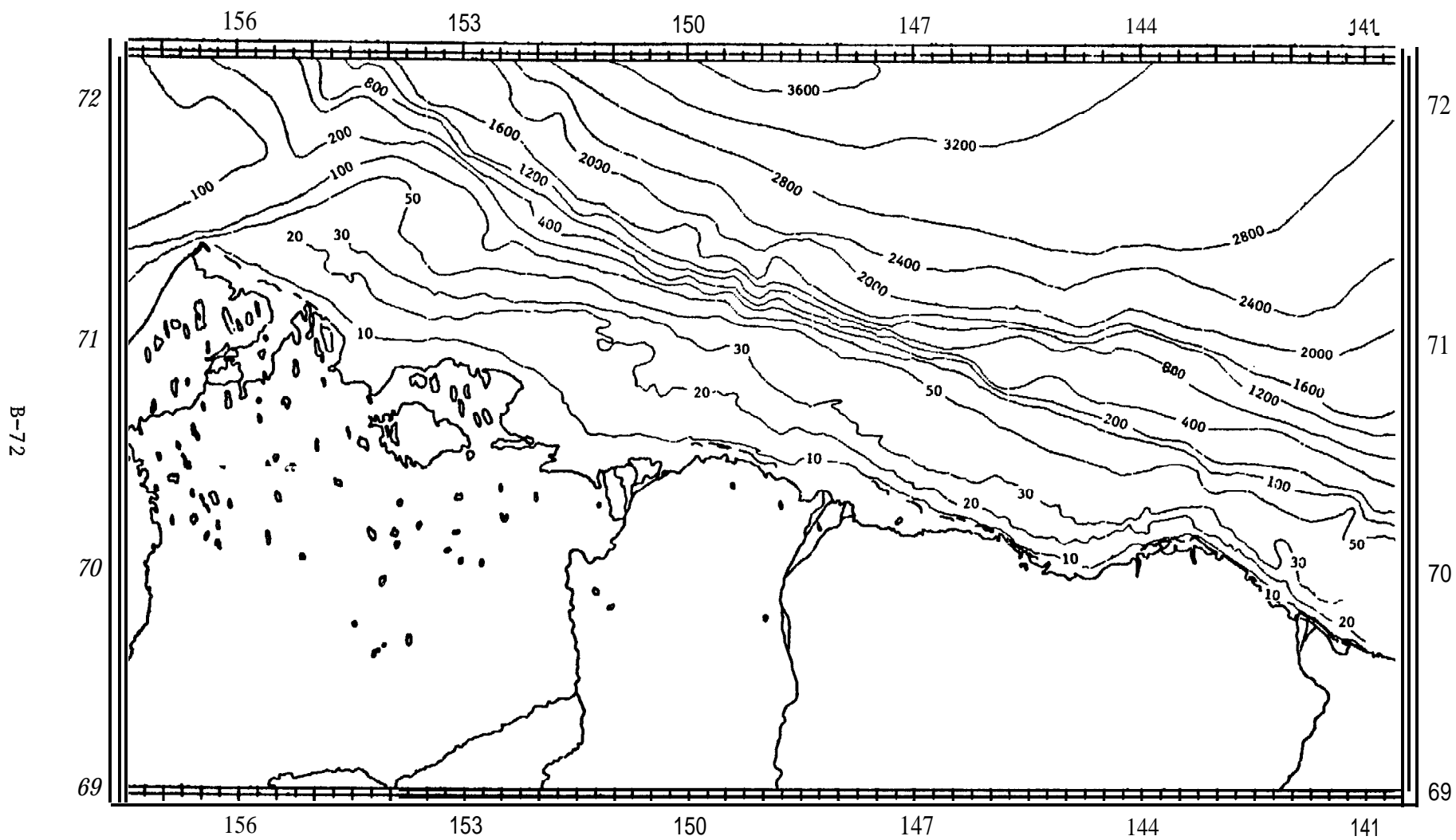


Figure B-41. Beaufort Sea depth contour lines, in meters.

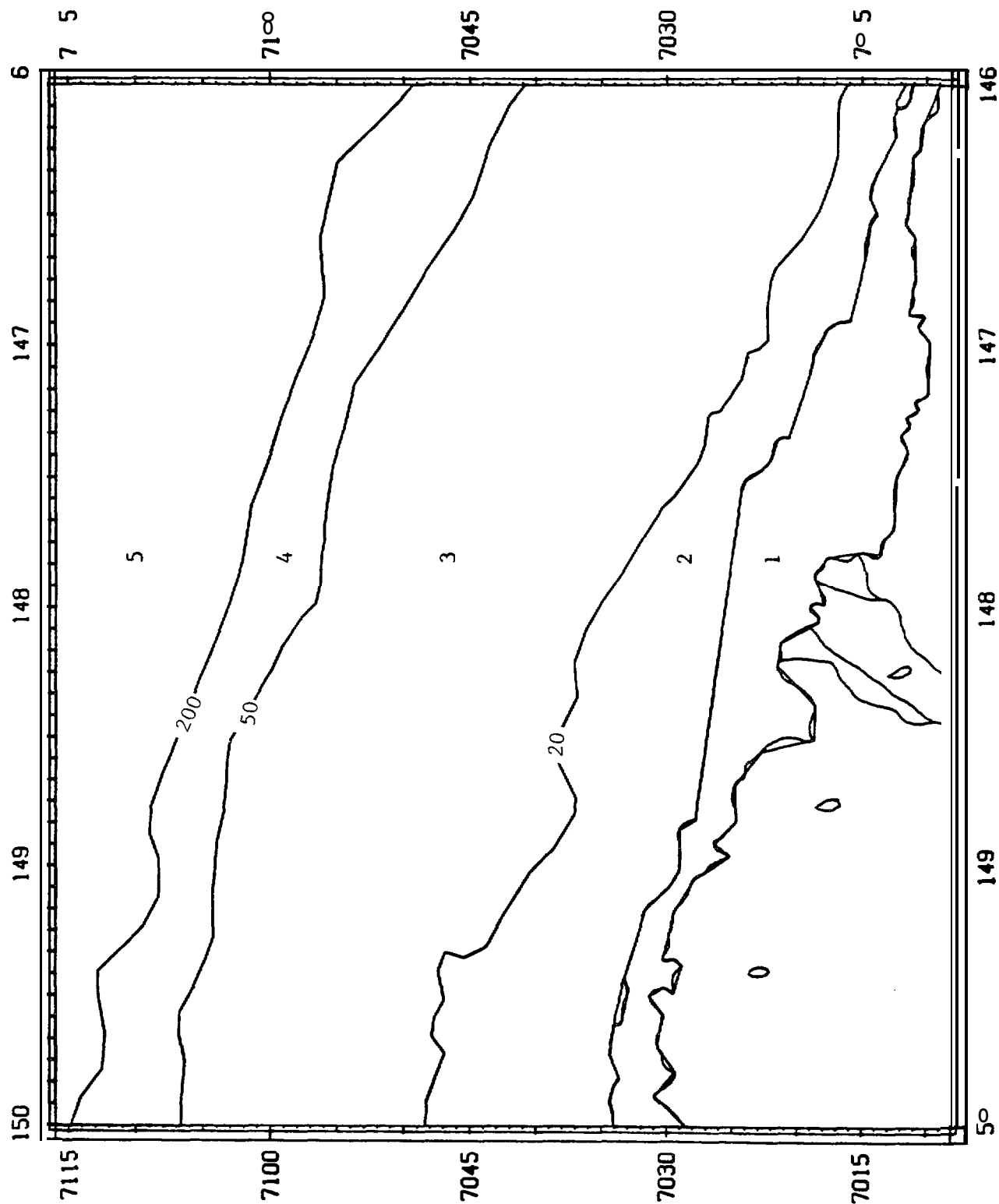


Figure B-42. depicting Beaufort Sea region numbers.

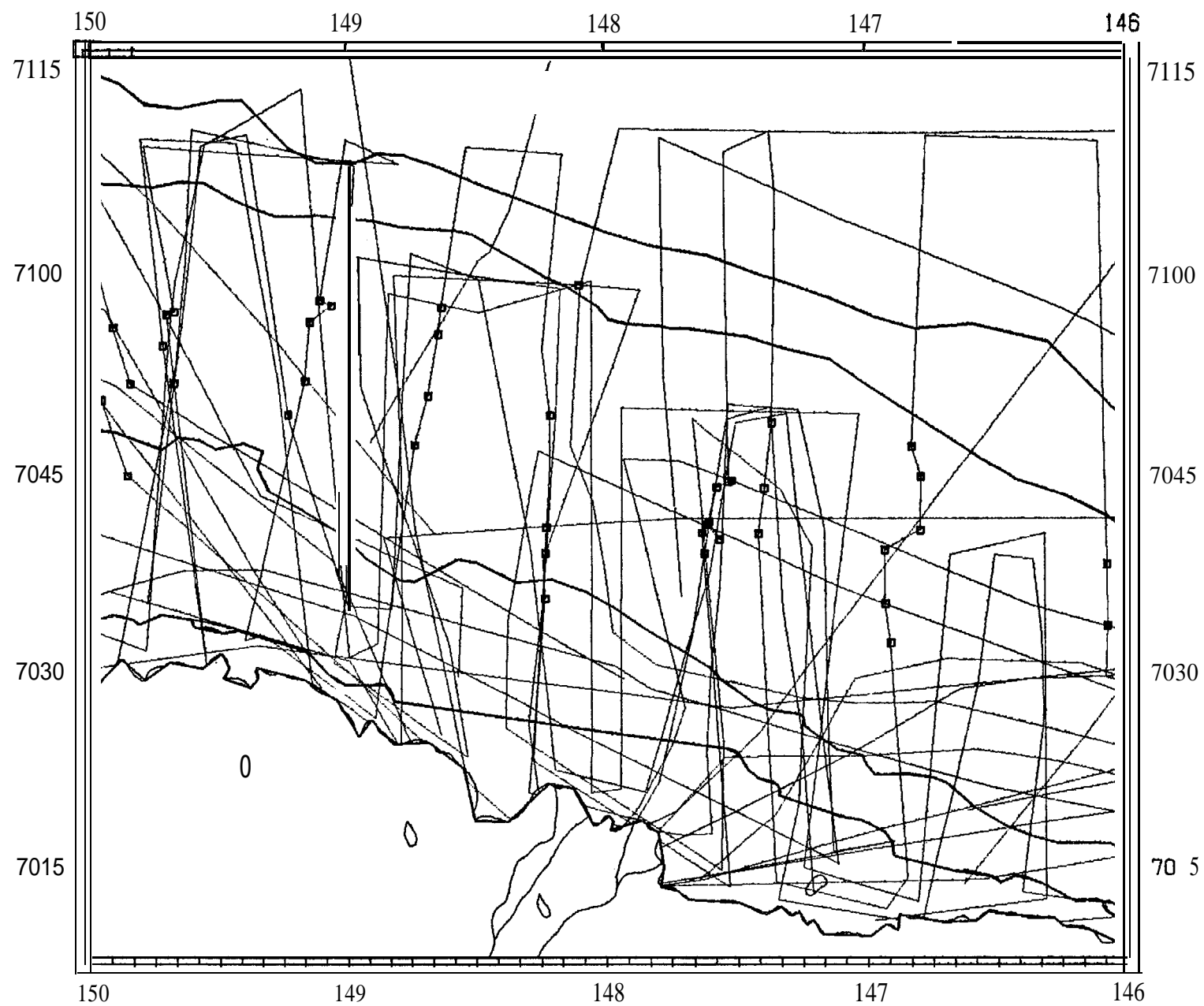


Figure B-43. Plot of aerial survey **tracklines** flown during September-October 1982 in the Beaufort Sea. Black squares represent bowhead whale sightings.

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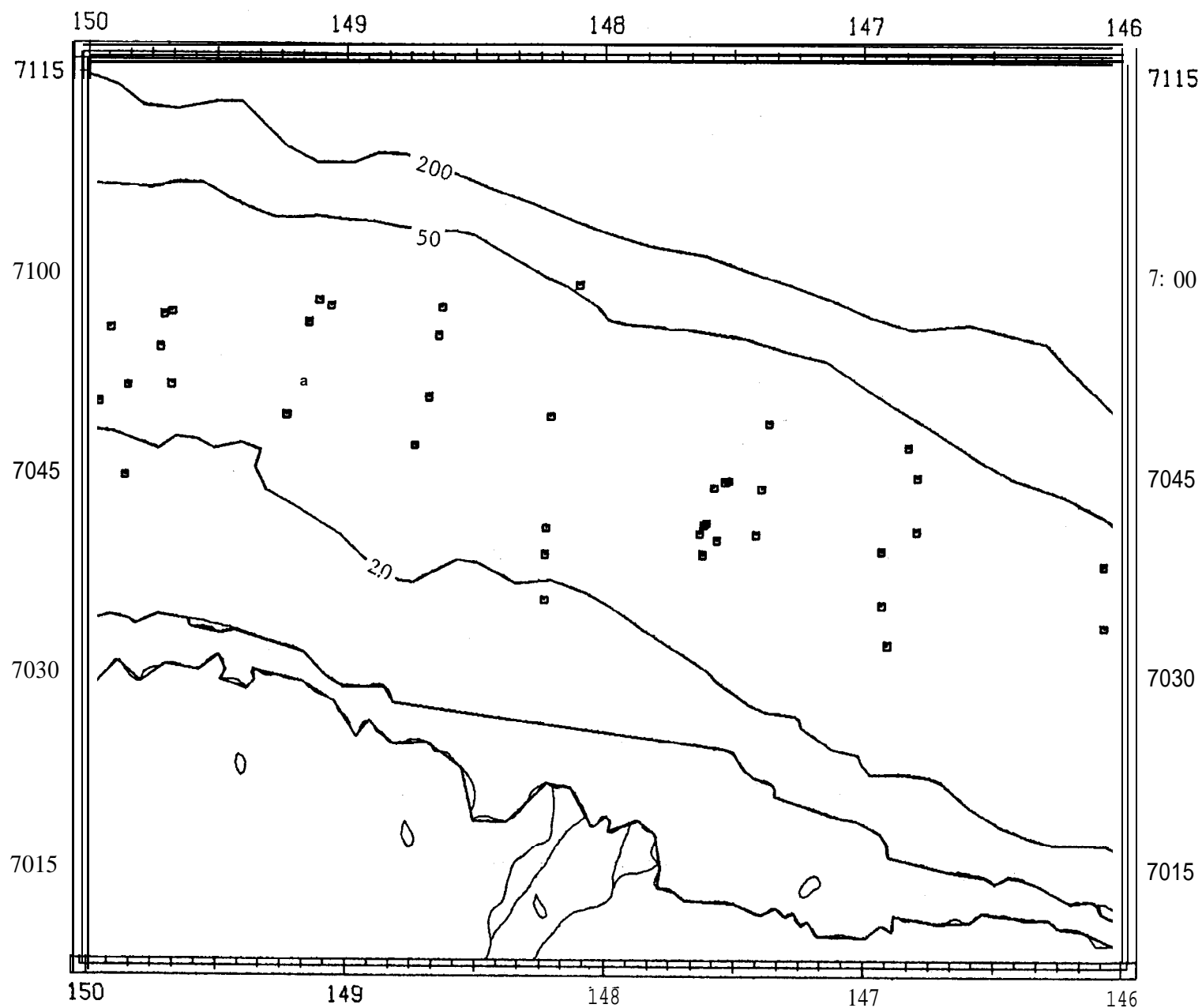


Figure B-44. Plot of bowhead whale sightings made during the September-October 1982 aerial surveys of the Beaufort Sea, Black squares represent bowhead whale sightings.

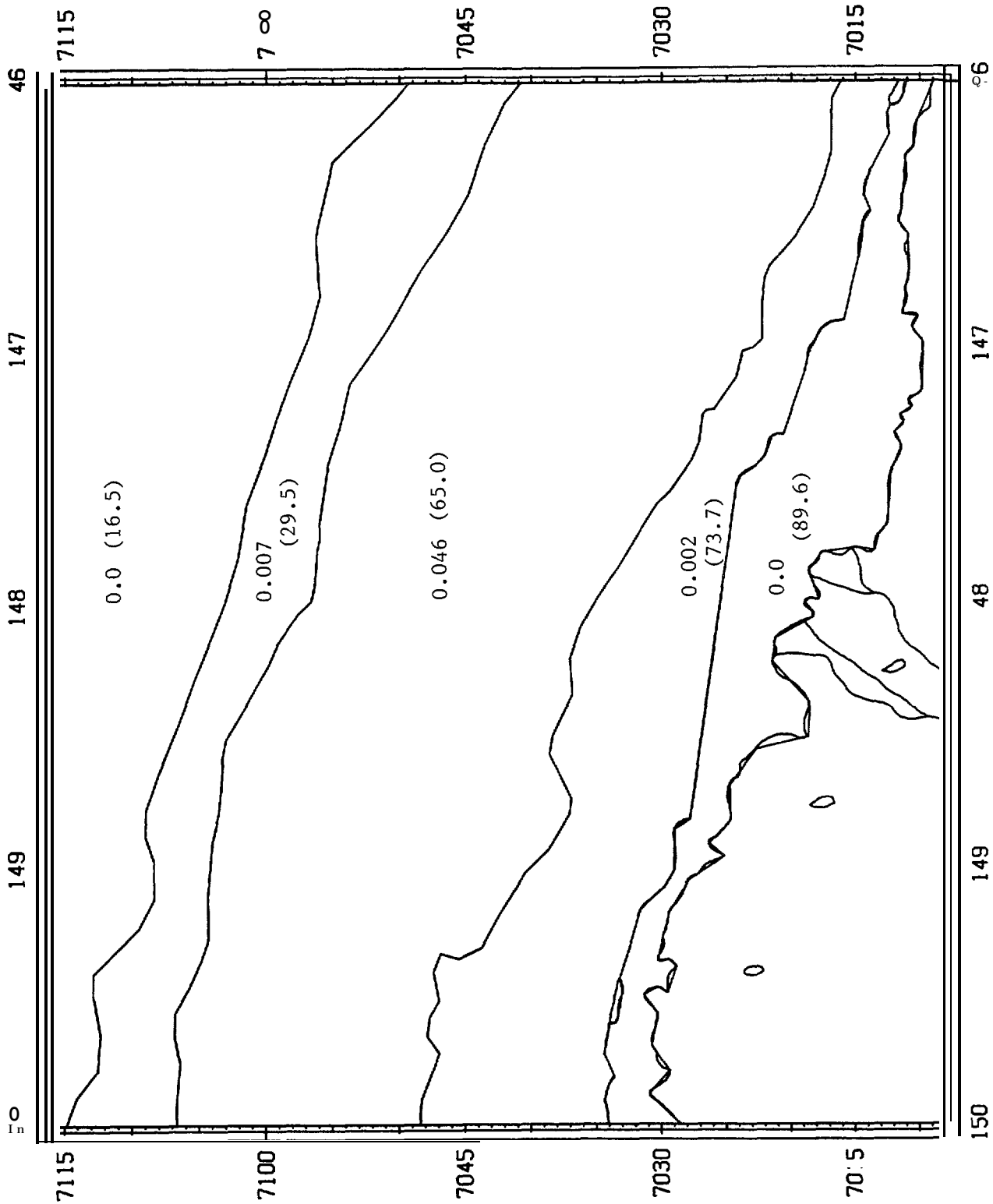


Figure B-45. Values shown are observed densities of bowhead whales as determined from aerial surveys flown in the Beaufort Sea during September-October 1982. Values in parentheses indicate percent of area surveyed.

Table B-13. Statistics from aerial survey of bowhead whales conducted September-October 1979-1982 in the Beaufort Sea. Values for each region where summed where appropriate. Region numbers refer to areas depicted in Figure B-42. The total area of all regions was approximately 4,482 nmi². Areas were approximated by straight line integration and thus minor discrepancies exist between the summation of areas of sub-regions and the area calculated for the total region.

Year	Region: C	Region Area nmi ²	Percent of Total Area	Percent of Area Surveyed	Survey Time HR:MIN	Number of Transects Flown (=n)	Number of Bowheads Observed	Density as Number per nmi ²	Variance	Confidence Range of Density
1979	Total	4,458	100.00	172.94	85:31	104	83	0.011	>0.0	0.005 - 0.017
	1	428	9.55	438.28	20:37	168	0	0.0	0.0	0.0 - 0.0
	2	687	15.33	238.03	16:36	202	6	0.004	>0.0	>0.0 - 0.012
	3	1,905	42.50	194.50	42:55	128	77	0.021	>0.0	>0.009 - 0.032
	4	488	10.89	45.70	1:50	35	0	0.0	0.0	0.0 - 0.0
	5	974	21.73	40.67	3:22	26	0	0.0	0.0	0.0 - 0.0
1980	Total	4,458	100.00	153.07	59:00	89	9	0.001	>0.0	>0.0 - 0.002
	1	428	9.55	273.58	11:57	144	0	0.0	0.0	0.0 - 0.0
	2	687	15.33	250.95	14:27	170	2	0.001	>0.0	>0.0 - 0.002
	3	1,905	42.50	188.07	30:05	123	7	0.002	>0.0	>0.001 - 0.003
	4	488	10.89	52.52	1:46	37	0	0.0	0.0	0.0 - 0.0
	5	974	21.73	9.52	0:38	11	0	0.0	0.0	0.0 - 0.0
1981	Total	4,458	100.00	105.23	35:08	164	21	0.004	>0.0	0.002 - 0.007
	1	428	9.55	153.63	4:32	101	0	0.0	0.0	0.0 - 0.0
	2	687	15.33	211.03	10:42	138	1	0.001	>0.0	>0.0 - 0.003
	3	1,905	42.50	125.04	18:29	131	19	0.008	>0.0	0.004 - 0.012
	4	488	10.89	39.17	1:21	41	1	0.005	>0.0	>0.0 - 0.017
	5	974	21.73	1.18	0:06	7	0	0.0	0.0	0.0 - 0.0
1982	Total	4,458	100.00	54.53	17:39	101	59	0.024	0.4	0.011 - 0.037
	1	428	9.55	89.57	2:36	65	0	0.0	0.0	0.0 - 0.0
	2	687	15.33	73.66	3:30	58	1	0.002	>0.0	>0.0 - 0.006
	3	1,905	42.50	64.97	9:05	67	57	0.046	2.7	0.013 - 0.079
	4	488	10.89	29.49	1:08	31	1	0.007	0.4	0.0 - 0.019
	5	974	21.73	16.45	1:19	17	0	0.0	0.0	0.0 - 0.0

Since 1979 no bowhead whales have been sighted inside the Barrier Islands or in subregion C1 (0-10 m. depth) although a cumulative 39.7 hours of effort has been expended there in 478 transect crossings covering 955.06% of the total area of C1 (Table B-13). The sighting closest to the islands was of two bowheads seen from Jeanette Island on 9 September 1980 during examination of a yearling carcass that the ice had deposited on the island. They were not²sighted from the air. Density in subregion C2 never exceed .004 whales/rm .

On 16 September 1980 there was a sighting of a bowhead near the spits to the east of Barter Island in subregion D1 (Ljungblad, 1981). Also in mid-September 1980 there were several other sightings just outside subregion D1 (14 September, 9 bowheads east of Barter Island, 18 September, 4 bowheads northeast of Barter Island; Ljungblad, 1981).

Literature Cited

- Estes, J.A., and J.R.Gilbert. 1978. Evaluation of an aerial survey of Pacific walruses (Odobenus rosmarus divergent). J. Fish. Res. Board Can. 35: 1130-1140.
- Krogman, B.D., H.W. Braham, R.M. Sonntag, and R.G. Punsley. 1917. Early spring distribution, density, and abundance of the Pacific Walrus (Odobenus rosmarus) in 1976. Outer Continental Shelf Environmental Assessment Program Research Unit 14 Final Report, No. R7120804.